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PATENT LAW REFORM IN BRITAIN

THE second interim report of the Departmental Committee on the Patents and Designs Acts*, appointed in April 1944 by the President of the Board of Trade, deals with the two aspects of the patent system of Great Britain on which public interest has been mainly concentrated during the past few years, namely, the alleged abuse of monopoly rights under our patent system and the grievance concerning the grant of worthless patents and the legal procedure for the determination of patent rights. In its first interim report the Committee recommended a modification of the procedure for making applications for extension of the term of patents in cases where the patentee has suffered loss or damage as a consequence of the War, and its recommendation has been implemented in the Patents and Designs Act, 1946, which has just received the Royal Assent.

Recommendations in the second interim report are based on the results of an inquiry by the Committee in which it considered first the broad fundamental question, whether the maintenance of the patent system of Great Britain upon its present basis is justified as being still conducive to the attainment of those objects for which it was originally designed. The theory upon which the present system is based is that the opportunity of acquiring exclusive rights in an invention stimulates technical progress mainly in four ways : first, that it encourages research and invention ; secondly, that it induces an inventor to disclose his discoveries instead of keeping them as a trade secret ; thirdly, that it offers a reward for the expense of developing inventions to the stage at which they are commercially practicable ; and fourthly, that it provides an inducement to invest capital in new lines of production which might not appear profitable if many competing producers embarked on them simultaneously. The Committee expresses the opinion that the history of industrial development seems on the whole to have justified this theory, mainly because similar patent systems are in operation in almost all industrial countries, the only departure having been made by the Soviet Union. In the Soviet Union there is maintained, concurrently with the existence of a patent system of the usual type, an alternative method of encouraging and rewarding inventors by direct Government grants. The Committee is of opinion that this system is bound up with the particular economic system in which it operates, and has little bearing upon the problems of a country in which technical progress largely depends upon private initiative ; and it seems to us probable that this opinion will be generally endorsed. The technical progress of Great Britain has coincided with our patent system operating in conjunction with industrial research organisations financed by large companies, and long-term research arrangements supported by Government and private benevolence.

* Board of Trade. Patents and Designs Acts. Second Interim Report of the Departmental Committee. (Cmd. 6789.) Pp. 38. (London : H.M. Stationery Office, 1946.) 9*d*. net.

Several of those who had made public statements about the suppression of inventions were invited to give evidence, but did not accept the invitation; and the inquiry made by the Committee led to the opinion that the allegations of deliberate suppression of inventions and of other abuses of monopoly rights have been much exaggerated. The Committee favours the retention of the general frame of our patent system but recommends several important improvements. Under the existing provisions of the law relating to compulsory licensing of patents, an allegation of abuse of monopoly rights may be made to the Comptroller-General of the Patent Office, who determines the remedy most appropriate to the particular case—possibly a compulsory licence or even revocation of the patent. The Committee recommends some extension of these provisions so that facilities may be given for the grant of compulsory licences in cases where a more extended use of a patent could be made, even if no actual abuse of patent rights has taken place. In particular, where a patentee is exploiting a patent to the full extent of his ability but there are still other uses of the invention or potential demands for the patented article which remain undeveloped or unfulfilled, it would be in the public interest that an applicant who is in a position to open up a new field of manufacture should be at liberty to apply for a licence; equally, where the patentee is meeting the demand in the home market to the fullest extent but the export market is neglected or insufficiently supplied with the patented article.

Some of the evidence submitted to the Committee was directed towards advocating, as a remedy for the abuse of monopoly rights, that all patents when granted should be endorsed 'licences of right' in the same way as a particular patent may be endorsed if the patentee desires. If this proposal were adopted, it would reduce the patent grant to a right to receive royalties for the use of the patented invention, and the Committee considered how far this proposal would weaken the efficacy of our patent system in stimulating research, in promoting the disclosure and development of inventions, and in attracting investment for the working of inventions. It came to the conclusion that royalties would be an inadequate inducement to undertake heavy expenditure on development. It might be possible to fix royalties in such a way as to reimburse the patentee for the expense of development of the particular invention concerned; but much expense is incurred in following false trails, and it would be difficult to devise a system of royalties for making successful inventions carry the cost of useful but unremunerative research. On the evidence, the Committee does not recommend the adoption of the system of compulsory endorsing of all patents.

The proposed revision of the law concerning the grant of worthless patents and the legal procedure for the determination of patent rights is directed mainly to the second main public grievance. Under the existing law the Comptroller-General of the Patent Office has no power to refuse an application for a patent for an invention which obviously lacks inventive merit or, as it is termed, 'subject-matte[r]'. The grant of patents for such inventions is, *pri[ma] facie*, contrary to public policy and also contrary t[o] the purpose of the patent law, the object of wh[ich] has always been to encourage genuine inventions without imposing undue restraint upon normal industrial development. The Patent Offices of th[e] principal industrial countries, such as those of the United States, Germany, Sweden and Holland, have power to refuse applications for patents which, in their opinion, are lacking in subject-matter. There is evidence that patents granted by the patent offic[es] of such countries have a higher validity value, a[nd] therefore a better chance of commercial exploitati[on] than patents granted in countries where the questi[on] of subject-matter is not considered. The Committ[ee], with two members dissenting, recommends that t[he] Comptroller-General should be given power to ref[use] applications for patents on the ground of lack [of] subject-matter, and we believe this recommendati[on] will be generally approved.

On the legal procedure for determination of pat[ent] rights, the Committee's recommendations may receive criticism, though there will be much support for the view that there is need for some amendment. Th[e] commonest and most familiar ground of complaint is the high cost of patent litigation; but there is al[so] undoubtedly a very general lack of confidence in th[e] adequacy of the tribunal before which these paten[t] cases come, and the feeling that the judges char[ged] with the task of deciding patent actions have not t[he] necessary scientific or technical knowledge or experi[-] ence to assess the value of the expert evidence or to arrive at sound conclusions, where the invention [in] question involves the discussion of highly complex chemical, electrical, mechanical or physical matters. Those who have knowledge of High Court procedu[re] are aware that it is a common occurrence in pate[nt] actions that a considerable time, possibly some days, is taken in instructing the judge in the elements o[f] technology with which the invention is concerned, [in] order that the specification can be made intelligible to him, and the retention of highly paid counsel an[d] experts makes a very serious addition to the tot[al] costs of such actions. The Committee has come [to] the conclusion that the principal reform necessary [in] the trial of patent actions is that they should co[me] before a judge appointed, as at present, from membe[rs] of the Bar, but also possessing sufficient technical [or] scientific qualifications to enable him to grasp t[he] broad technical principles of such cases witho[ut] extensive preliminary explanation or instruction. [It] recommends that two special judges, possessing te[ch-] nical or scientific qualifications and experien[ce of] patent litigation, should be appointed to hea[r] patent actions: either judge to be available to act [as] the patents appeal judge to hear appeals from decisio[ns] of the Comptroller-General. A scientific assista[nt] should sit on all occasions with the special judge [to] try patent actions unless the judge, after hearing t[he] parties, decides that such assistance is unnecessar[y].

As a further means of reducing the cost of paten[t] litigation, the Committee recommends that th[e] Comptroller-General of the Patent Office should b[e]

authorized to try cases of alleged infringement where the parties agree to adopt this course. In such a case the Comptroller-General would be authorized to grant damages up to £1,000, but he would not have power to grant an injunction.

It is possible that some of the proposed procedure is open to criticism in detail; but if its broad outlines can be put into practice it will, in our opinion, go far to remedy long-recognized defects and to simplify and cheapen legal procedure in connexion with the patent system of Great Britain.

SCIENCE PRESENTS ITSELF

Mr. Tompkins Explores the Atom
By G. Gamow. Pp. x + 97. (London: Cambridge University Press, 1945.) 10*s*. 6*d*. net.

Electrons in Action
By James Stokley. (Whittlesey House Publication.) Pp. xi + 320 + 37 plates. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 18*s*.

Science in Progress
By Walter R. Miles, Selig Hecht, George D. Birkhoff, Henry Eyring, K. C. D. Hickman, Edwin J. Cohn, Detlev W. Bronk, Otto Loewi, Peter Debye, Isidore I. Rabi, and C. A. Elvehjem. Edited by George A. Baitsell. Fourth Series (Society of the Sigma Xi, National Lectureships 1943 and 1944). Pp. xvi + 331. (London: Oxford University Press, 1945.) 20*s*.

IF one may judge by the appearance of the bookshop windows and the bookstalls there is, at the moment, quite a minor boom in popular science in the publishing world. The part played by science in the Second World War and the publicity given to it in the Press have made science 'news' to an unprecedented degree, and authors and publishers seem to have guessed that the man in the street will want to know more about it. As might have been expected, in the circumstances, some of the resulting volumes bear every mark of having been hurriedly put together to catch the market—ephemera, for which no long-continued existence can be prophesied. In the meantime, the output of more authoritative and serious works has not slackened; three of these form the subject of this review. Science, we all know, is, or at any rate used to be, international; but a British reviewer may be pardoned a little quite friendly envy that all three books should have been written in the United States, and two of them published there. One would wish, out of sheer gratitude if for no other reason, that more could be done to put this form of 'lease-lend' into reverse.

Since Aristotle drew the distinction between 'productive science' and the science which 'exists for itself' each has had its devotees among men of science; and, no doubt, the same division of interest may be found among the readers of popular science books. It is to the latter class that Prof. Gamow addresses himself in "Mr. Tompkins Explores the Atom". One feels that Prof. Gamow loves his atoms—he has spent much of his life investigating them—as the devout lover worships his mistress; not for their utility, but for themselves alone. They are so fascinating that he wants to tell the world about them; hence this quite delightful little book.

This is not Mr. Tompkins' first appearance in scientific literature. Readers fortunate enough to have met this engaging little bank clerk in the early days of the War will scarcely have forgotten the fantastic adventures (induced by a rash decision to substitute the heady excitement of the physics lecture room for the more soothing solace of the cinema) he was fated to undergo in those strange quantum lands in which mathematical physicists live and move and have their being during working hours. Not only did they serve to while away the tedium and the terror of some anxious hours; they left, one may frankly confess it, a clearer picture of relativity and quantum theory than one had gathered from far more portentous expositions. In the present volume Mr. Tompkins, now happily married to the professor's daughter, Maud, is thereby exposed to still further draughts of the physical intoxicant. The three dreams which ensued, the three lectures by which they were stimulated, and a further lecture—thrown in as a make-weight so to speak—which Mr. Tompkins did not attend because his father-in-law advised him that it would be well over his head, make up the book.

In the first chapter Mrs. Tompkins, with Maxwell's demon for cicerone, is taken for a tour among the molecules of her husband's whisky and soda. In the second Mr. Tompkins, transformed into an electron, finds himself odd-man-out (or valency electron) on a sodium atom. Finding it rather lonely he transfers to the *M*-shell of a neighbouring chlorine atom, meets his partner of 'opposite spin', and has some high old times ("How am I going to explain this to Maud when I see her again ?"), until he is ejected by a photon, to be finally annihilated by a savage positive electron. The final dream introduces us, and Mr. Tompkins, to the dear old gentleman (in appearance, if we may trust the author's sketch, a cross between old man Gepetto from "Pinocchio" and the late Lord Rutherford) who makes the atomic nuclei. The extra lecture deals with the Dirac theory of the positron, and so clear is the exposition that I see no reason why Mr. Tompkins should have been warned off it.

Sequels are notoriously apt to be disappointing; and it cannot truthfully be said that in the present volume Prof. Gamow quite recaptures the wild raptures of his earlier book. The genial humour, the flashes of insight, and the author's almost uncanny skill in making difficult matters plain are in no way diminished. The conceptions in terms of which modern science interprets atomic phenomena are, however, not so remote from everyday experience as those in which the mathematician interprets time and space; and so offer less scope to the author's imagination. Since the first atom bomb startled the world, the atom has become definitely 'news'. The manuscript of "Mr. Tompkins" was completed before Hiroshima put atoms in the headlines; there are no atom bombs in the book. One cannot imagine, however, that the book would have been essentially different had it been written three years later. It is the atom itself and not merely one of its more unpleasant potentialities which interests Prof. Gamow, and all the scientific background to the release of atomic energy is already in the text. The non-technical reader who wishes to appreciate something of this background cannot do better than accompany Mr. Tompkins in his explorations. He will not find a pleasanter, more authoritative or more illuminating guide.

In our enthusiasm for Prof. Gamow's book we have kept the practical man waiting for a rather unconscionable time. Mr. James Stokley's book will

make him ample amends. The title "Electrons in Action" is reminiscent of G. R. Harrison's admirable "Atoms in Action", but the resemblance goes little further. Apart from one or two concessions to the general reader in the early chapters, "Electrons in Action" is, in the main, a straightforward and competent account in moderately non-technical language of the whole science of electronic engineering as seen through American eyes. Two short chapters tell the reader all he needs to know about the electron itself; a further chapter describes the use of electron tubes as rectifiers, amplifiers and oscillators; the rest of the book is concerned with the applications of these, and other, electronic devices in industry, science, medicine and the arts including, of course, the art of war.

Considering that J. J. Thomson's original discovery of the electron will not celebrate its jubilee until next summer, it makes an impressive story. Broadcasting, television, fluorescent lighting, automatic industrial control, sound recording and production, and electron microscopy make a formidable list, even if we omit, as the author might have been well advised to do, X-rays (which, in point of fact, were discovered before electrons), and atomic energy, in the release of which electrons play no vital part. How could one have imagined that Thomson's curiosity as to the real nature of electricity should have been the foundation of several major industries, or that the original 'e/m tube', which one used to see lying around on a dusty shelf in the Cavendish Laboratory, should have begun to proliferate at a rate reminiscent of the herring and the puff-ball.

It says much for the restraint of the author that he has, in the main, confined himself to plain, unvarnished narrative. He has assumed that his prospective readers are already interested and wish to be instructed. This he proceeds to do. The underlying principles, and in some cases the details of the various techniques of electronics, are carefully described, and the reader who will work patiently through the book (it is not a volume to be skimmed) will find himself at the end with a useful general outline of the subject.

Mr. Stokley writes clearly and concisely, and has packed a good deal of information into his 309 pages of text. Some useful line diagrams, and a number of not very illuminating plates of the usual type supplied by commercial manufacturing corporations, illustrate the text. In getting up his brief, the author, who is not himself, we gather from the dust cover, a radio-engineer, has consulted the leading research workers of most of the great American corporations concerned with electronics, so that the information is both up to date and authoritative, so far as American developments are concerned. His contacts on the eastern side of the Atlantic, possibly owing to war conditions, seem to have been far fewer, and his general picture becomes thereby a little one-sided. Perhaps he may be able to rectify this in the next edition.

So far, in these latter days, has the pace of scientific discovery outstripped, not only growth of human morality, but also the capacity of the individual human mind, that men of science are beginning to find it impossible to keep abreast of new developments in other sciences or even (let us confess it) in their own. To remedy this unfortunate state of affairs, the "Society of the Sigma Xi" arranges annually a number of national lectures, in which specialists in one branch of science provide, for colleagues whose main interests lie in some other direction, authoritative surveys of important recent advances in their own speciality. These lectures, as many readers of *Nature* will remember, are collected from time to time into single volumes and published under the general title "Science in Progress". The present volume is the fourth of the series. It contains two articles on nerve impulses, one from the electrical, the other from the chemical, aspect, and a very interesting account of determinations of the smallest number of quanta required to stimulate the sensation of vision. On the chemical side we have accounts of recent work on the vitamin B complex, on the chemistry and separation of proteins, particularly those to be found in blood plasma, an article on modern vacuum chemistry with applications to the vitamin A industry, and on the more physical side a study of the distribution of energy in a molecular system, rates of reaction, and inhibition of luminescence. On the pure physics side we have a résumé of low-temperature production, and an article on molecular beams, together with a very charming and personal article on some aspects of mathematical physics from the pen of the late Prof. Birkhoff. As an innovation these are prefaced with a detailed, and possibly rather over-documented, account of the application of psychological methods in the American Army Air Force. All have been written by authorities of indisputable standing, who are actually concerned in the work which they describe.

Confronted with such a varied assortment, what is there for a reviewer to do? All the articles are obviously of high quality and importance. Omniscience alone could deal adequately with the whole of them, and a selection would express only the writer's particular interests and personal bias. The line of least resistance is to advise everyone who is interested in the progress of science to buy a copy for himself (the mere pleasure of handling once again a book so perfectly and beautifully produced is worth more than the modest twenty shillings at which it is priced) and to make his own selection. This we unhesitatingly do.

Two comments, however, can be made. In the first place, the choice of subjects to be included seems to have been somewhat restricted by the secrecy imposed on many branches of science by the exigencies of war. One can only hope for the sake of science itself—which flourishes best in the open—that some, if not all, of these official shackles may have been struck off before the fifth series of "Science in Progress" makes its appearance. In the second place, we would implore the editor of this very distinguished series to use whatever influence he may have with his contributors to induce them to remember the shortness of human life and the limitations of the human intellect, and have pity on our weakness. We are all interested in what they have to tell us, but few of us are adepts in their particular line of country. There is a tendency in every series of progress reports to become more and more technical, and thus less and less widely comprehensible, with each succeeding volume. Of the earlier volumes of the present series one felt that even the non-professional man of science might read them not only with profit but with pleasure. Now one is not so sure. In one or two of the articles in the present volume (it would be unfair to specify which) one has the feeling that the distinguished author has had in mind (perhaps unconsciously) colleagues in his own subject who have fallen in arrears with their reading owing to war-time preoccupations. There is a place for such articles—in the professional journals. Those of us, and we are not a few, who believe in the unity of science, and

strive to take an intelligent interest in the achievements of sciences not our own, have so welcomed the help we have received from previous volumes of "Science in Progress". May we hope that their successors will not prove too hard for our understanding.

J. A. CROWTHER

THE INSIDE STORY OF THE SKULL

Anthropoid and Human Endocranial Casts

By Pierre Hirschler. Pp. ix + 150 + 11 plates. (Amsterdam: N. V. Noord-Hollandsche Uitgevers-mij., 1942.) n.p.

THE calvarium of the mammalian skull is moulded over the brain which it contains. Hence a cast of the inside of the skull reproduces in a general way the form of the brain itself. It is for this reason that the study of endocranial casts assumes some importance in palæontology, and particularly in the palæontology of man and the other primates. But it has also been the subject of an intermittent controversy which bursts out afresh with every new discovery of fossil man or ape.

The point at issue is simply this—how much really reliable information regarding the shape and convolutional pattern of the brain is it in fact possible to obtain from an endocranial cast? The enthusiastic anatomist studying a fossil human skull of primitive type is naturally eager to glean all the information possible from his material, and the danger is that in his eagerness he may exceed the bounds of objectivity. There can be no doubt that this danger has not infrequently been sufficiently realized, even by anatomists of considerable repute; to such an extent, indeed, that the study of endocranial casts has tended in the recent past to degenerate into a sort of neo-phrenology, in spite of the fact that careful studies of endocranial casts of modern man and apes compared with the actual brains have already shown that the casts reproduce but little more than the general form and proportions of the brains.

From the Central Institute for Brain Research in Amsterdam there has now appeared a detailed and comprehensive work by Dr. P. Hirschler on anthropoid and human endocranial casts. This monograph (which should be thoroughly digested by students of human palæontology) is introduced by a critical review of the literature of the subject.

The author is particularly (and, we think, rightly) outspoken about those anatomists who appear to assume that every unevenness of the surface of an endocranial cast must be a fissural imprint; who claim that the relative size of a localized eminence can be taken to signify the possession of such mental faculties as the power of speech; or who ignore the influence of membranes, subarachnoid cisterns and blood vessels in the determination of irregularities on the cast surface. So far as the large anthropoid apes are concerned, Hirschler finds that endocranial casts show extremely few fissural markings which can be identified with certainty, a conclusion which is the more striking since the casts studied were made from skulls specially selected because the walls of the intracranial cavity showed well-marked juga cerebralia. In casts made from human skulls fissural markings can be identified on the orbital surface of the frontal lobe, near the anterior border of the frontal lobe, and on the temporal lobe. Elsewhere they are usually not present [redacted] form, though as a very unusual rarity (possibly the result of a pathologically high intracranial pressure) they may be abnormally distinct.

When the critically minded demur at the confidence with which some anatomist claims to be able to identify on the endocranial cast of a fossil skull most of the details of the convolutional pattern of the brain, they are commonly met by two rejoinders. The first is that, while such details may not be discernible in the case of modern man and apes, for some unknown reason they happen to be much more distinct in the particular fossil under discussion; the second is that only after an intensive examination of the cast over a period of weeks and months—scrutinizing it from all angles of light and shade and palpating it repeatedly with the finger-tips—is it possible to express a confident opinion. But it must be clear that conclusions based on such subjective evidence can by themselves have little scientific value.

There seems only one way of securing a true interpretation of a fossil endocranial cast, and that is to circulate duplicates of the cast to a number of neurological anatomists and to request each to make an independent assessment with special reference to the identification of sulcal markings. By collating the results of such a group study, it may be possible to eliminate those variables which are clearly of subjective origin and to secure agreement on those identifications which may be taken as reasonably certain.

W. E. LE GROS CLARK

ADVANCES IN MEDICINE

The March of Medicine

(New York Academy of Medicine Lectures to the Laity, No. 9.) Pp. xiv+121. (New York: Columbia University Press; London: Oxford University Press, 1945.) 11*s.* 6*d.* net.

THIS volume contains six lectures, and represents the ninth series of "Lectures to the Laity" which have been given under the auspices of the New York Academy of Medicine. These lectures are well known, and a number of small volumes have already been produced which are of great interest to professional men and laymen alike. The general title of the present series is "War and the Expanding Frontiers of Medicine". While the lectures are all good, some will be of greater interest than others to medical men and scientific men generally. The lecture by Dr. Strecker was evidently delivered with the purpose of boosting national morale, but the need did not necessarily disappear with the cessation of hostilities. Dr. King's lecture on food and civilization is thoughtful, and also practical in that he recommends action, not only against contaminated food but also against food of poor quality. He quotes illuminating figures which emphasize the great extent of malnutrition in the United States. Dr. MacLeod gives a straightforward and admirable account of the development of chemotherapy. Sir Gerald Campbell lets his humour play impishly around the alleged benefits of science to mankind. While he does not doubt that these have actually been benefits, he is sceptical regarding the ability of the human race to use them properly. The final lecture is by Lieut.-Colonel Thomas T. Mackie, who presents a really excellent review of the interrelation between wars and epidemics. The volume is up to the high standard [redacted] by its predecessors.

NUCLEAR ENERGETICS AND β-ACTIVITY*

By PROF. M. N. SAHA, F.R.S., and A. K. SAHA
University of Calcutta

EVER since the discovery by Joliot and Curie of the phenomenon of induced radioactivity in 1934, a very large number of radioactive nuclei, exceeding 450, has been prepared in the laboratory. In recent years, new types of radioactive nuclei have been obtained from fission of heavy nuclei like $_{92}U$, $_{90}Th$ and $_{91}Pa$, and possibly also of $_{93}Np$ and $_{94}Pu$; which have, however, not yet been released for publication. Extensive studies of the β^- and β^+ activities of these nuclei have been made in the various laboratories of the world. The data so far collected, though they have reached vast magnitudes, are by no means sufficient, but already they form a rather bewildering mass (for example, see tables by Seaborg[1]), reminding one of the vast collection of spectroscopical data, before the rise of the modern theories of the electron-structure of the atom reduced them to a few simple laws like Pauli's exclusion principle.

Z:	18	19	20	21
	A^{41}	K^{43}	Ca^{45}	Sc^{47}
	—	—	—	—

In addition to the nuclei like C^{14} which have been prepared in the laboratory, we have nuclei, mostly stable, occurring in Nature the number of which now reach nearly 250. In the case of nuclei derived from fission, the designation of a new isotope by mass is occasionally not quite unambiguous; indeed, this is a very acute problem for fission products.

Several attempts at a regularization of data have been made by previous workers, but here we shall refer to a chart prepared by Saha, Sarkar and Mukherjee[2], a section of which is shown in Fig. 1; the full chart is too large to be reproduced here. This is a synthesis of several charts already published by different authors. In this, the abscissa represents mass-number M, the ordinate represents the isotope number $I = N - Z$, which represents the excess of neutrons over protons in any nucleus. M ranges from 1 to 239, and I from -1 to about 54. The section of the chart reproduced here extends from $I = -1$ to $I = 8$. We have attempted to make the chart as up to date as possible. The parallel lines at 45°, henceforth to be called the Z-lines, represent the atomic number Z. Thus all isotopes of the element Z are to be found on the same Z-line. Each isotope is represented by a circle. Solid circles, ●, represent 'stable nuclei'. Hollow circles, ♂, with an arrow pointing upwards represent β^+-(positron)-emitting nuclei. When the arrow points down, ♀, it indicates that the nucleus is β^--(electron)-emitting. Circles with arrow pointing both up and down, ⚥, indicate that the nucleus emits both negatrons and positrons, for example, Cu^{64}. ♂ denotes that the nucleus decays by K-capture only. ♂ denotes that the nucleus decays by K-capture as well as by positron-emission. ♀ denotes that the nucleus has been obtained in 'fission'; such nuclei are all β^--emitting. If any particular isotope has two different half-lives (isomers), both half-lives are given (compare Co^{62}). Saha, Sirkar and Mukherjee[2] gave the following rules of stability, some of which were previously known:

Rule 1: I is even.

When I is even, say 4, we get alternation of stable and β-active nuclei, as shown below:

Z:	15	16	17	18	19	20	21	22	23	24	25	26	27
	P^{34}	S^{36}	K^{38}	A^{40}	K	Ca^{44}	Sc^{46}	Ti^{48}	V^{50}	Cr^{52}	Mn^{54}	Fe^{56}	Co^{58}
	—	S	—	S	—	S	—	S	—	S	—	S	+

S denotes stable, — denotes negatron-emitting, + denotes positron-emitting.

Exceptions. There are certain exceptions: (*a*) He^6, B^{10}, C^{14} are β^--active, though both N and Z are even. (*b*) H^2, Li^6, B^{10}, N^{14} are stable, though both N and Z are odd. These rules have been given by Bethe and others.

Rule 2. I is odd, say 5: We have

22	23	24	25	26	27	28	29	30	31	32	33
Ti^{49}	V^{51}	Cr^{53}	Mn^{55}	Fe^{57}	Co^{59}	Ni^{61}	Cu^{63}	Zn^{65}	Ga^{67}	Ge^{69}	As^{71}
Stable								+	+,	+	+

(—) denotes negatron-emitting, (+) denotes positron-emitting.

The above is illustrative of all groups having I odd. If in any of the odd groups we arrange the nuclei in order of their mass numbers Z, we first get β^--emitting nuclei, then a succession of stable nuclei, which are followed by β^+-emitting nuclei.

These rules apply only to known nuclei. If in future it be possible to extend the series on both flanks, will the new nuclei follow these rules? We need not consider the nuclei with odd I because evidently rule 2 will continue to apply to them. Let us consider nuclei with I even: they may be illustrated by a typical group, say $I = 4$; we may think of the possibility of forming some day in the laboratory $_{12}Mg^{28}$ and $_{14}Si^{32}$, on the left flank, and $_{32}Ge^{68}$, $_{34}Se^{72}$, on the right flank, though these are at present unknown. Will they be stable, or unstable like $_6C^{14}$ with a long life?

An explanation to these rules, and a clue to the energetics of β-emission, is afforded in a general way if we write out the formula for mass-defect of nuclei in the form $\Delta M(Z,A) = \varphi(Z,A) + \chi(Z,A)$, where $\varphi(Z,A)$ is the spin-independent part, which is given by one of the various mass-defect formulæ due to Weizsäcker, Bethe or Wigner. We have taken, for the sake of simplicity, the Weizsäcker–Bethe form

$$\varphi(Z,A) = \alpha.A - \beta\frac{I^2}{A} - \gamma A^{2/3} - \frac{\delta Z^2}{A^{1/3}} \quad . \quad (1)$$

with Bethe's values of the constants α, β, γ, δ. These values were based on older data on masses of nuclei, but probably the newer data will give better values. But these have not been available to us. We have sometimes adjusted the value of β, but this is an unsatisfactory procedure from the theoretical point of view. The Weizsäcker–Bethe formula holds only for Z even, N even, for which the nuclear spin $i = 0$, and the spin-dependent term $\chi(Z,A) = 0$.

The Spin-dependent Term

When I is even and Z odd, N odd, for example, in $_7N^{16}$, we have found uniformly that $\chi(Z,A)$ is negative and of the order of a few million electron-volts. For odd I, no general principle has yet been found.

From the general mass-defect formula, expressions for the ene... ...ease in β-transitions have been ... E^- be total energy-release in a

* Summary of a paper by M. N. Saha and A. K. Saha, "On Nuclear Energetics and β-Activity", *Trans. Nat. Inst. Sci. India*, 2, 193 (1...

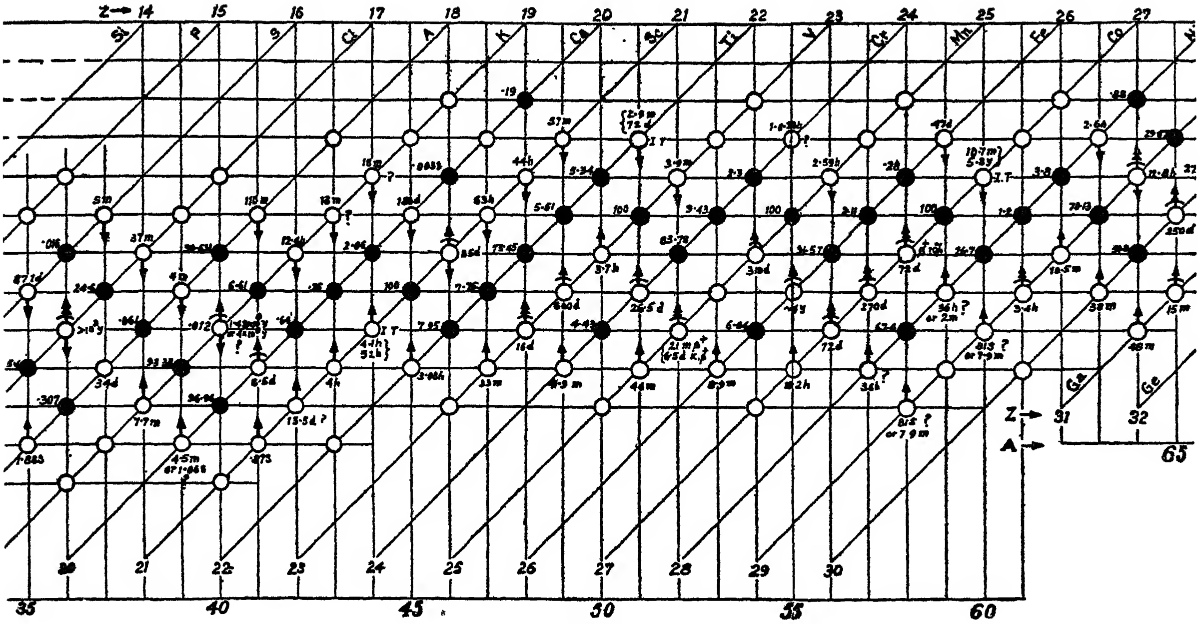


Fig. 1

β^--transition in which a nucleus ${}_ZM^A$ changes to ${}_{Z+1}M^A$; then it can be easily shown that

$$E^- = A^- + \chi(Z+1, A) - \chi(Z,A),$$

where

$$A^- = 0\cdot766 + \frac{4\beta(I-1)}{A} - \frac{\delta(A-I+1)}{A^{1/3}} \quad \text{in Mev.} \quad . \quad . \quad (2)$$

The χ-functions may be multi-valued, corresponding to the different nuclear levels of both parent and daughter nuclei. For β^+-emission, let us denote by E^+ the total energy-release in a β^+-transition when the nucleus ${}_ZM^A$ changes to ${}_{Z-1}M^A$. It can be easily shown that

$$E^+ = A^+ + \chi(Z-1,A) - \chi(Z,A),$$

where A^+ is the spin-independent part given by

$$A^+ = -1\cdot788 - \frac{4\beta(I+1)}{A} + \frac{\delta(A-I-1)}{A^{1/3}} \quad . \quad (3)$$

For K-capture, the energy E^K released in the process, which is taken to be carried by the neutrino, is given by

$$E^K = E^+ + mc^2\{1 + \sqrt{1-\alpha^2 Z^2}\} \simeq E^+ + 2mc^2 \quad . \quad (4)$$

Energy-Release

In cases where the β-transitions are of a simple allowed type, the energy-release is simply equivalent to the end-energy of the β-spectrum, for in general in such cases no γ-rays are emitted. Where such is not the case, but β-rays are of the forbidden type, for example, in Na^{24}, and γ-rays are also emitted, the task of finding the energy-release from the β- and γ-radiations emitted is a rather difficult one, and every case has to be dealt with separately. A typical case is afforded by Na^{24}, which has been discussed by Kruger and Ogle[3] and by Maier-Leibnitz[4]. In such cases we have to examine with great care the decay scheme of the β-transitions as given by different authors; but this is not easy, for the data are very often contradictory.

According to these formulæ, the values of E^-, E^+ and E^K depend on I and A, and on the spin-dependent terms $\chi(Z,A)$. The classification of nuclei according to I-values is therefore justified.

It is obvious that a nucleus is stable with respect to β^--emission when E^- is negative, and with respect to β^+-emission when E^+ is negative. But for the right-hand nuclei of the nuclear chart, even when E^+ is negative, the nuclei may decay by K-capture, provided E^K is greater than 0, or E^+ is greater than $-2\ mc^2$, which is approximately 1 Mev. The line of stability is therefore depressed by -1 Mev. below the zero-line, for the right-hand nuclei.

The operation of these rules is best illustrated by taking one or two typical examples for I odd and I even separately. We first take I odd, and choose the group $I = 3$. This is illustrated in Fig. 2. Here the abscissa represents the mass number M, the ordinate represents A^- and $A+$, calculated from formulæ (2), (3). The known nuclei extend from O^{19} to Ga^{65}. If the χ-terms contributed nothing to E^- or E^+, all nuclei for which A^--values were below the zero-line, and A^+-values below the line ($-$ 1) would have been stable, namely, from S^{35} to Ti^{47}, and the energy-release would be given by the values of A^- and A^+ against each mass number.

Actually we have all nuclei from Cl^{37} to Ti^{47} stable, with the exception of A^{39}, about which we have extremely meagre data and probably wrong information. S^{35} is very nearly stable—it has a long life of 87·5 days. We have for S^{35},

$$E^- = A^- + \chi(18, 35) - \chi(17, 35).$$

The A^- is below the zero line, $\chi(18, 35) - \chi(17, 35)$ is evidently positive, and these terms take E^- slightly above the zero line. E^- is only 0·103 Mev. according to the measurements of one of us (A. K. Saha), but if there is a γ-ray emitted by S^{35} in cascade, as claimed by Giebert *et al.*[5], E^- is 0·233 Mev.

The energy-release in the case of β^--active and β^+-active nuclei generally follows the A^- and A^+-curves. The ringed points give the actual values, wherever available. On the right-hand side, however, data are generally very uncertain; but whatever is available appears to be in agreement. V^{49} is nearly

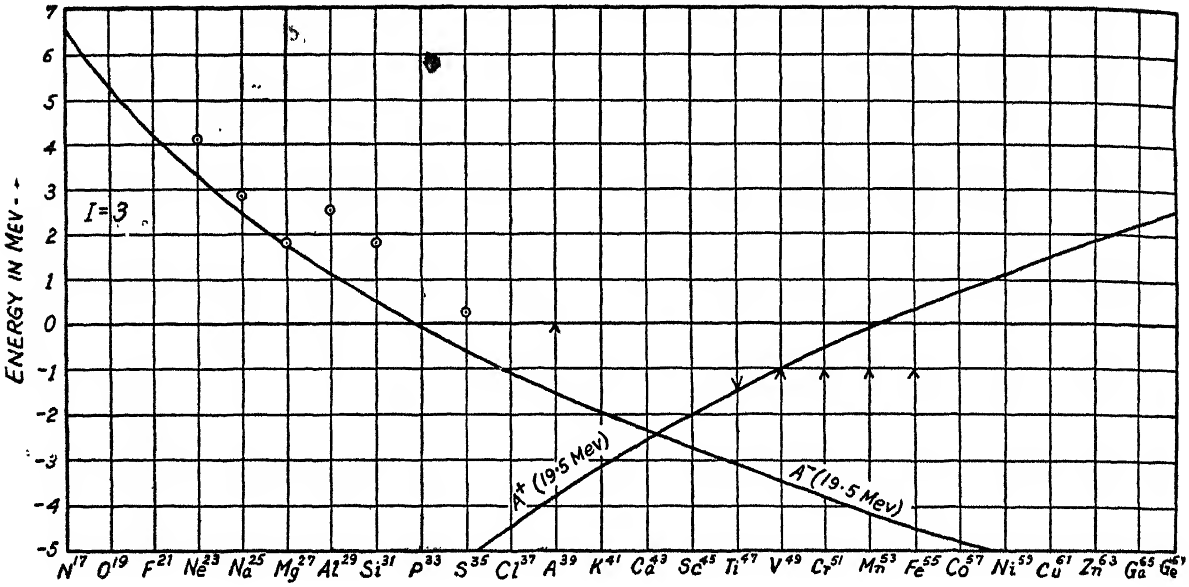


Fig. 2

stable, decaying only by K-capture and having a long life of 600 days. As we proceed outwards the nuclei release progressively larger amounts of energy, and become short-lived. When E is large, intermediate levels are formed and the energy-release takes place through β-rays and γ-rays emitted in cascade. As mentioned earlier, the data on such cases have to be carefully sifted, and most are yet uncertain.

When I is even, we can place the nuclei in two categories :

1. *Even-even nuclei* (N even, Z even). For such nuclei we have

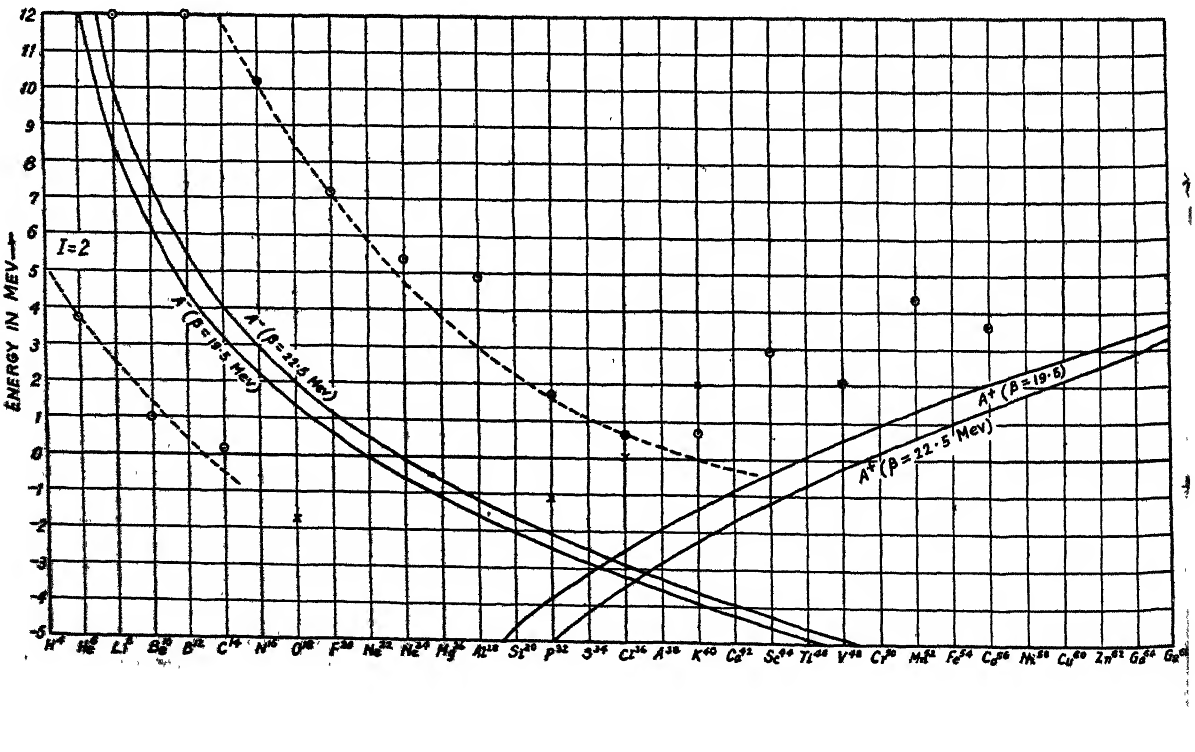
$$E^- = A^- + \chi(Z+1, A) < A^-,$$
$$E^+ = A^+ + \chi(Z-1, A) < A^+ \quad . \quad (5)$$

for $\chi(Z,A) = 0$, when Z, N are both even, and $\chi(Z,A)$ is uniformly negative when Z and N are both odd. Hence Z being even here $\chi(Z+1, A) < 0$.

2. *Odd-odd nuclei* (N odd, Z odd). For such nuclei we have, since Z is odd,

$$E^- = A^- - \chi(Z, A) > A^-,$$
$$E^+ = A^+ - \chi(Z, A) \gtrsim A^+ \quad . \quad (6)$$

The operation of these rules is illustrated by the case $I = 2$.



The known nuclei for $I = 2$ range from He^6 to Ga^{64} and the operation of rules (2), (3) is illustrated in Fig. 3. The A^-- and A^+-curves have been drawn for two values of β, namely, 19·5 and 22·5 Mev. The first is Bethe's value, the second is a trial value. The ringed points give us the observed values of energy-release. It shows that $\chi(Z,A)$ is negative whenever Z is odd and is of the order of 3–5 Mev. The dotted curve has been drawn for β^--emitting nuclei with Z odd. For even-even nuclei, such a curve would be parallel to the A^--curve, but according to (5), as much below it, roughly, as the odd-odd nuclei values are above. Only a section of it passing through the points He^6, Be^{10} and C^{14} is shown. Here the $|\chi(Z,A)|$ terms are smaller than $|A^-|$, which is large on account of small values of M, the mass number, and hence the nuclei are negatron-emitting, though both Z and N are even; but the value of E^- is far smaller than those of contiguous odd-odd nuclei like B^{12} or N^{16}, where the two terms are additive. The curves give a rough indication as to the value of energy-release in a β^--emission. From O^{18} the A^--values become smaller as the atomic mass is large, though χ's continue to be of the same order and all even-even nuclei have E^- negative and therefore the nuclei are stable.

On the right-hand side, the ringed dots show the energy-release wherever known. The stability of even-even nuclei up to Ni^{58} is easily explained. The next even-even nuclei like Zn^{62} or Ge^{66} will prove to be either stable or decaying by K-capture with a long life.

Cl^{36} and K^{40}, which are in the middle of the group, are especially interesting. Cl^{36}, like Cu^{64}, has been found (Grahame and Walke[6]) to decay both by β^--emission to A^{36} as well as by K-capture to S^{36}. K^{40}, which occurs naturally, is similar, as it decays by negatron emission to Ca^{40}, and by K-capture, but probably also by positron emission to A^{40}, as several investigators have found, but its spectrum requires re-investigation. Positron emission by K^{40} is indicated by the annihilation radiation of 0·5 Mev., found by Klemperer.

It has been found for other groups that all nuclei which decay by simultaneous emission of negatrons on one hand, and positrons or K-capture on the other hand, like Cu^{64}, occur round about the points where the A^--curves cut the A^+-curves.

So far, we have examined the data available for nuclei belonging to the groups $I = -1$ to $I = 6$, and in more recent work by A. K. Saha and S. Ghosal, the method has been extended from $I = 7$ to $I = 20$. We have generally confirmed that the stability of nuclei, and the energetics of β-emissions, can be explained in the same general way; but it is not so easy to deal with level-formations in the nucleus. Probably the agreement will be far better when a more accurate mass-defect formula for even-even stable nuclei is available. A few important deductions arising out of the present investigation may be noted.

(*a*) Li^5 is expected to be a nucleus having a long life of several years, and decaying by K-capture to He^5, which should be stable.

(*b*) A^{39}, reported as a β^--nucleus with a life of 4 min., is a glaring anomaly. A^{39} is expected to be a long-lived nucleus decaying by K-capture to K^{39}.

(*c*) Even-even nuclei may not always be stable, if the nucleus is a bit off the main line of stability. Thus Ti^{44}, Cr^{48}, etc.; if they could be prepared, they would be found, like C^{14}, to be long-lived products, decaying in these cases by K-capture.

(*d*) It is probable that Ca^{48}, stated by Nier to be a rare stable isotope of calcium with a frequency of 0·2 per cent, is illusory, like Co^{57}, which was once believed to be stable, but was predicted by us to be unstable. This prediction has been confirmed; recently I. Curie[7] has independently come to the view that a stable Ca^{48} does not exist. This nucleus, and Ti^{52}, Cr^{56}, Fe^{60}, if they could be made, would be found unstable, decaying like C^{14} with the emission of slow β^--rays. The first stable nucleus in the group $I = 4$ should be Ni^{64}.

(*e*) The radioactive nuclei V^{50}, Mn^{54}, Co^{58} should decay with both β^+ and β^- emissions and K-capture, but only β^+-emission and K-capture activity have been reported so far. If they are found not to emit β^--rays, a fundamental difficulty arises in the theory of β-emission.

(*f*) The spin-dependent part of the nuclear binding energy, namely, $\chi(Z,A)$ is found generally to be of the order of a few million electron volts, while according to classical theory it should be $\simeq \frac{Zev}{cr^2}\mu_K$, where Z is number of charges in the nucleus, v is the velocity of a nucleon inside in the nucleus, and μ_K is the nuclear magnetic moment. Making plausible assumptions about these quantities, we find that $\chi(Z,A)$ is of the order of about 10–20 kilovolts. This shows that we have to apply some type of meson theory to find out the right order of value of the spin-dependent part of the nuclear binding energy. Actually, D. Bose has deduced the right order of value for $\chi(Z,A)$ using the vector meson theory of Kemmer, but as theories of meson field, as Louis de Broglie has said, are not yet definitive, this point has not been pursued further.

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DIELECTRIC PROPERTIES OF RAW COTTON

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SOME evaluation of the dielectric properties of cotton at various moisture contents was needed because of a project to use thermionic heating on the eighty ovens of the Alexandria Testing House. The directly usable facts having been obtained, it seemed worth while to extend the inquiry by measuring the dielectric 'constant' in fields which traversed the hair lengthways, instead of the usual transverse direction. Facilities for preparation of such material were freely available from our spinning test mill. Results show that the values are twice as large lengthways, the 'K' of cotton dried at 100° C. being about six longitudinally and three transversely. It is not surprising that such a structure as the cellulose wall of the cotton hair[1] should be electrically anisotropic, and the results obtained have some interest for interpretation of the properties of all fibrous materials, including wood.

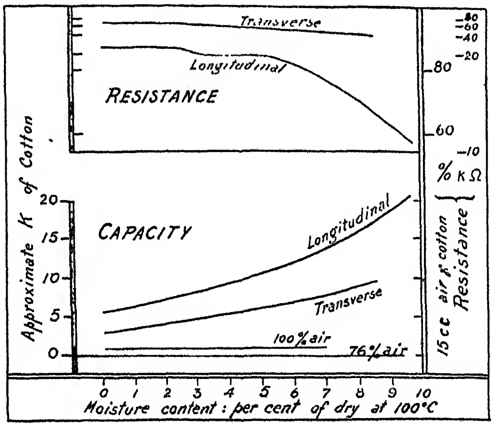
The cotton was packed between plates of stiff perforated duralumin, forming a condenser enclosed in a casing through which air could be circulated by

a pump, the assembly being light enough to weigh on a chemical balance after sealing. Capacity was measured by subtraction on a calibrated variable condenser in a rejector circuit loosely coupled to an oscillator, crystal-controlled at 1,755 kc. Resonance was indicated by a thermionic voltmeter with a device for indicating the mean of the two flanks of the resonance curve automatically. Adjustments for zero and range on the millimeter enabled the height of the resonance curve to be read off as a percentage of its height when the circuit was not loaded; this percentage was calibrated in terms of the equivalent shunt resistance, henceforth described as the 'resistance' of the cotton. The capacities measured ranged from 5 to 1,000 $\mu\mu$F., and were read to $\frac{1}{2}$ $\mu\mu$F. below the 250 $\mu\mu$F. level. The capacity of any condenser in air determined by calculation was checked experimentally by subtracting 'parasitic capacities' due to bolts, casing, leads, etc., or by replacement of air by paraffin wax.

Cotton is an inconvenient material. Most of the condensers used had two external earth plates, the live plate being registered in position between them and left floating between two layers of cotton. The whole condenser was compressed in a vice, and held together by small bolts passing through clearance holes in the live plate, after which the registering pins were removed. Densities of about 50/50 by volume were the greatest thus obtainable. Inter-electrode distances ranging from 5 to 1 mm. were chiefly used. This distance could be changed with the cotton inside by altering the fourteen clamping bolts, and in this way the dielectric constant could be computed. The value of 'd' at any adjustment was obtained by averaging dial micrometer readings of the total thickness of the condenser. This 'variable-d' method could not be used for the longitudinal field, for which the hairs had to be cut to a fixed length, fitting exactly between the plates.

The intransigence of air-dry cotton for these packing operations can be overcome by soaking with water, either boiling or at reduced pressure. A pack of ten million hairs on end, each 4·8 mm. long, inside a circle of 7 cm. diameter, was thus obtained with no other support than a thin encircling band of muslin varnished with 'Perspex'. A bundle of six draw-frame slivers (0·26 hank) was dragged through a series of 'Perspex' washers, each 4·7 mm. thick, with a 5·22 mm. hole; a safety-razor blade between the washers parted off one from another, leaving each hole filled tightly with a plug of short hairs. When all the hair had been displaced by water these plugs could be pushed out and handled for a short time before they began to expand, and a hundred of them were thus packed honeycomb fashion on the earth plate of a condenser, the live plate being fixed over them in contact, registered on three small 'Perspex' pillars, and the whole assembly dried to constant weight in the usual air-stream. After completing the measurements the same condenser was repacked with the same weight of cotton (to 1 per cent) inside the same volume, but with draw-frame sliver of hairs parallel to the plates, and the readings repeated. The latter pack contained approximately 1·7 million complete hairs, the cotton being Karnak Fully Good of 0·00137 mgm. hair weight, and 29 mm. mean length. The results in Fig. 1 show a remarkable contrast.

For the longitudinal field the picture is clear; we are dealing with ten million little condensers containing cellulose, in parallel with similar ones



Same condenser, same weights and volumes (cotton 24%; air 76% by volume).
Fig. 1

containing air, and the capacity follows the relative volumes, or plate areas, occupied by each. So the longitudinal dielectric constant in the dry condition is 6, without ambiguity.

That the values for a transverse field appeared to be just half of this was at first regarded as fictitious and due merely to a form-factor. Tests with strips of celluloid seemed to confirm this; strips on edge had nearly double the capacity of strips packed horizontally; the series formula for alternating layers of different dielectric seemed to apply, and the real K then was about the same. But if this formula holds we cannot account for the rise of capacity with additional moisture content, such rise being trivial in a loosely packed condenser. The analogy appears to be rather with a mixture of gases, the cotton and the air each contributing its volume-proportionate share to the total, just as in the longitudinal field. On this computation the transverse dielectric constant of dry cotton is 3 only, as plotted, and the rise of capacity with additional moisture is predictable. That each increment of moisture should raise K more than its predecessor is quite reasonable. The transverse curve is shown in more detail in Fig. 2, which shows a rather lower K at 7 per cent moisture than is shown by Fig. 1. The former is more likely to

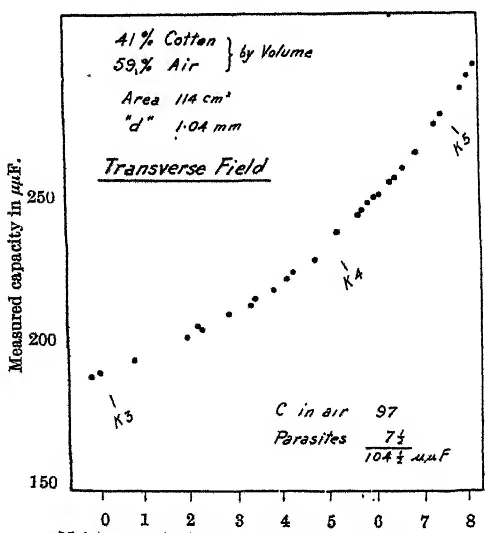


Fig. 2

be correct, because it tallies with results from 'variable-d' measurements, and the small values handled in Fig. 1 were designed for exact comparison, rather than for absolute measure.

For practical application in thermionic heating the prediction of capacity which will result from hand-packing a given weight of cotton into a known volume of inter-electrode space must be rather approximate. The hairs are variously oriented and neither curve of Fig. 1 will apply. From simple geometrical considerations it is evident that the transverse field result will be closely applicable with tight compression, and an average of the two if the hairs were fluffily oriented in all directions. Neither condition would be met in testing-house practice. Rough trials indicate that it should suffice to take the transverse field value and raise it by 10 per cent.

The above results can only be considered as fair approximations, for the sources of error with cotton are various. The volume of dry cotton is calculated from the weight on the value accepted, of 1·55 sp.gr. But we know that the cotton swells as it takes up moisture[2]; How and when does this appreciably affect our computation ? One may even ask, What is cotton?

Another error had to be compromised, namely, the lag of cotton in attaining moisture equilibrium. Slater's work[3] showed that three days should elapse before testing after any change of moisture content. We minimized this by re-circulating air through the perforations of the condenser, at ten litres a minute on an Austen diaphragm pump. Even so, though successive results plot smoothly during a day's work there may be a shift during the night, the magnitude of which varies with the packing, with the zigzag of the air-flow paths, and so on. It is rarely large enough to require correction by a final plotting of the curve through these stabilized points; thus, Fig. 2 is plotted from raw data.

A cognate source of error is the change of cotton temperature when gaining or losing water. With the condenser and a wash-bottle of water both nominally at room temperature, the cotton during recirculation may presently cease to take up any more water, or even lose water back to the bottle, as shown by a capacity-fall or by weighing. Changes in small steps mitigate this, but precision can only be got by three-day waits between changes.

There is, of course, no hysteresis loop in Fig. 2, because the actual weight of the cotton-water complex is plotted against the capacity, though the equilibrium lag can sometimes simulate it.

Particular attention was directed to the known phase boundaries of the relation between cotton-properties and moisture content, shown by the studies of Slater and Goshawk to exist in regions corresponding roughly to 3, 5 and 10 per cent moisture content. The present results are not good enough to provide a definite conclusion, but an anomaly in resistance was twice shown by longitudinal tests in the 3 per cent region, where Slater's longitudinal D.C. resistance curve is sharply bent; there is definite acceleration of the curves for both resistance and capacity in the 5 per cent region; the capacity curve is straight up to 3 per cent, as exemplified in Fig. 2. The 10 per cent region has only been roughly examined; a series condenser used to extend the range makes the resonance curve less blunt and more readable.

A point of interest in Fig. 2 is that the curve passes smoothly down through drying at 100° C. to drying at 115° C. More important is the fact that though the rise of capacity with moisture content accelerates, its rate of rise nowhere approaches the magnitude which free water with a K of 81 actually produced in the apparatus used. Up to 11 per cent moisture we are certainly not dealing with free water, but the stage when it appears should be interesting to examine.

Some determinations on wood were made by packing the condenser used for Fig. 1 with a hundred small wood cubes, arranged with the grain running from plate to plate (longitudinal field) and again with grain parallel to the plates (transverse field). A ratio of 16/10 in capacity was found. It would seem that the anisotropy is a property of secondary cellulose structures in general.

The encased and perforated condensers lent themselves to rough parallel determinations of the relative humidity of the air recirculating through them, using apparatus previously described[4]; also, of the obstruction to air-flow offered by the cotton as it swelled with water-intake, by putting an inclined differential alcohol manometer on the two sides of the casing. The results agreed with expectation, and a fuller investigation might include measurement of the cotton temperature by incorporating a thermo-junction in the live plate. Capacity, resistance, humidity, permeability and temperature could all be measured together.

My thanks are due to my colleagues, H. A. Hancock, D. S. Gracie and F. Khalil for all facilities.

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SHRINKAGE AND CRACKING OF CEMENTIVE MATERIALS

THE symposium organised by the Roads and Building Materials Group of the Society of Chemical Industry and held at the Royal Institution on May 8 was the first result of a suggestion made by Prof. J. D. Bernal, chairman of the Scientific Advisory Committee of the Ministry of Works, that there was need for more discussion of the fundamental problems associated with building. The subject chosen, the shrinkage and cracking of cementive materials, is not only one of major importance to all building technologists, but it also throws up many problems which, it is hoped, may engage the attention of the worker in pure science. The symposium was organised in collaboration with the Ministry of Works, and, in opening it, Sir Reginald Stradling, chief scientific adviser to the Ministry, pointed out that the problem of the dimensional stability of materials is a most important subject, and one which has engaged the attention of workers in this field over the last twenty years. Nevertheless, much still remains to be done, and he hoped that the contributions made to the symposium would lead to a clearer understanding of the nature of the problems.

Two of the papers, one by M. R. L'Hermite, director of the Laboratoires du Bâtiment et des Travaux Publics, Paris, and the other by Dr. F. M. Lea and Mr. C. R. Lee of the Building Research Station at Watford, dealt with problems of concrete, the former discussing recent studies made in the author's laboratory on the shrinkage of concrete, and the latter

giving a general survey of the main facts relating to shrinkage and creep phenomena and of the theories of their causes.

It is well known that, even in the absence of applied loads, concrete is liable to undergo volume change. Apart from thermal effects and other minor causes, these volume changes are caused by alterations in the moisture content of the material, and restraint of them leads to the development of stress and, in the limit, to cracking. Thus, when concrete changes from a saturated to a completely dry condition, the contraction occurring is approximately the same as that which would be calculated, on the usual simplifying assumptions, as arising from an applied compressive stress of the order of 800 lb. per sq in. Under complete restraint, therefore, the stresses which arise are of the same order as the normal permissible design compressive stress and greater than the ultimate tensile stress of the concrete.

Much can be done to reduce the risk of cracking; but nevertheless, cracking of concrete is of common occurrence and has come to be regarded as an annoying, and somewhat unpredictable, phenomenon. Rational design in concrete is affected by the fact that the stress/strain ratio under applied load is not constant, but varies with the time that the load has been applied. Thus, on application of a load, concrete exhibits an immediate elastic strain, and then a further progressive strain or creep which continues for years, and which may become several times greater than the original immediate strain. Creep will often act in such a way as to relieve the effect of shrinkage, and both are obviously of major importance in design. A typical value for the drying shrinkage of concrete is about 0·05 per cent, though this may vary considerably, according to the nature of the concrete and the conditions to which it is exposed. The shrinkage of concrete on first drying is in part irreversible; on subsequent cycles of wetting and drying a somewhat lesser movement occurs, but this is substantially reversible. Most measurements of shrinkage have been done on unrestrained specimens, but it is the stresses set up by restrained shrinkage rather than the magnitude of the free shrinkage which are of prime importance in practice.

Shrinkage of concrete has been variously attributed to capillary condensation, surface adsorption, solid solution or hydration phenomena. In the first two, attention is primarily directed to the pore structure of the mass, while in the latter two, it is the nature of the binding agent which is regarded as the dominating factor. Elaborating the capillary condensation theory, M. L'Hermite referred to recent studies with the electron microscope made in the United States, from which it appears that hydrated cement consists essentially of a matrix of interlaced fibrous crystals, in which are embedded other crystals of a more massive plate-like shape. Cohesion of the cement is to be attributed to the presence of these fibrous crystals, but their very large surface area must give rise to capillary and surface phenomena which, in M. L'Hermite's view, lie at the root of the dimensional changes of concrete with change in moisture content. Elaborating the capillary condensation theory, M. L'Hermite calculates the equivalent compressive stress induced in solids by water held in capillaries under tension and arrives at an expression relating shrinkage to the volume compressibility, relative humidity and combined water content of the concrete, which shows moderate agreement with the experimental results. As was pointed out, however, in other papers, there are numerous objections to capillary condensation as an explanation of volume change, and it is doubtful if it can at best be more than one of a number of factors concerned. M. L'Hermite also discussed the internal stresses set up in concrete by shrinkage, and in particular the stress in the reinforcement. From a consideration of the stresses in the concrete and the compression in the reinforcement, he is able to calculate the extent of cracking and the time at which it will occur.

Creep of concrete differs from plastic flow in metals in that it occurs down to the lowest stresses at which measurements are possible. For stresses within normal working ranges, creep for any one concrete is approximately proportional to the applied stress. The real distinction between shrinkage and creep in concrete is, however, not clear, for, in the case of specimens stored in air and undergoing creep tests, drying is usually occurring at the same time, and, with it, drying-shrinkage. The distinction between the two depends, therefore, on the assumption that they can be regarded as independent, and that creep can be measured as the increased deformation of a loaded specimen as compared with one which is not loaded but is maintained under otherwise similar conditions. Creep of concrete under water is not, of course, complicated by this shrinkage, though there is some slight expansion caused by further hydration of the cement. So far as all experimental evidence goes, creep is largely irrecoverable, but it has been argued that this is due to ageing effects in the concrete while under the test. Creep has been variously regarded as an irreversible phenomenon, as a delayed elastic phenomenon, and as such theoretically reversible, or as merely the consequence of non-uniform shrinkage. Much more data on the effect of the moisture content of concrete and of temperature on creep are vital to any theory.

In his paper on "The Swelling and Shrinkage of Porous Materials and the Role of Surface Forces in Determining the Technical Strength of Artefact Materials", Dr. D. H. Bangham pointed out that the common observation that a liquid tends to form drops means that the idea of a liquid possessing surface energy is easy to grasp; but it is not so easily realized that solids also have surface energy. Nevertheless, the surface tension of solids is many times greater than that of liquids. The reason why a powder does not coalesce into a solid mass is that the areas of contact between the grains are small, and the mutual pull of the particles is resisted by the rigidity of the material. The coalescence of solids thus depends partly on the magnitude of the surface forces and partly on the resistance to deformation. This, for example, explains why particles of wax with a low surface tension cohere together more strongly than particles of diamond with a high surface tension.

Meehan was the first to demonstrate in 1927 the swelling of charcoal when it absorbs gases and vapours. The detailed studies which have been made by Bangham and his collaborators have shown that the expansion is proportional to the surface-energy lowering which accompanies adsorption. This result is intelligible if it is remembered that the original size of the solid charcoal represents a compromise or balance between two opposing sets of forces: (1) the surface forces which, if left to themselves, would aggregate the material into a sphere of zero porosity; and (2) the elastic forces which impart rigidity to the material. The adsorption of the gas or vapour shifts the balance slightly against the surface forces, so that

the block expands. Some experiments carried out in the laboratories of the British Coal Utilization Research Association have, in fact, shown that adsorption of vapour does cause some diminution of the area of contact between sub-microscopic particles. Thus, in experiments on the electrical conductivity of a rod of coke-like material, it was found that, when adsorption swelling took place, the resistance increased, indicating that the width of the inter-particle contacts had diminished. Different types of irreversible shrinkage, all well known in technical practice, were mentioned. The first, ageing, is most marked with a freshly aggregated mass of very fine particles or filaments. The slow prevailing of the surface over the elastic forces is probably due to molecular relaxations within the solid particles, which absorb the elastic energy and impart permanent set, with permanent adjustment of the particles to each other's shape at the area of contact. The shrinkage associated with drying may represent a continuation of this process, since the surface forces would be increased. The process of sintering is another illustration of the relative instability of the powdered state. Raising the temperature renders less effective the energy barriers which impart rigidity, and this appears to be the essence of the process.

Capillary condensation, in Dr. Bangham's view, appears to be subject to very serious limitations as an explanation of volume change of solids with changing content of liquid. The decrease of surface tension of a solid caused by saturation with the vapour of a liquid far exceeds the surface tension of the liquid itself. Thus, the surface energy of solids is of the order of thousands of ergs per sq. cm., the lowering of surface energy of solids by saturation of vapours is of the order of hundreds of ergs per sq. cm., while the surface energy of water, for example, is seventy-five ergs per sq. cm., and that of alcohols only twenty-two ergs per sq. cm.

Mr. H. H. Macey (British Refractories Research Association), in his paper on the "Cracking of Plastic Clay Articles during Drying", discussed many of the technical problems involved in manufacture. In the manufacture of any article from clay the ground raw material is mixed with sufficient water to render it capable of being moulded to the required shape, and, afterwards, it is dried to remove this water, and then fired. Problems of drying to avoid losses owing to shrinkage cracking are thus of much importance to the clay industry. A mixture of clay and water shows two distinct portions in the volume shrinkage/moisture content curve. During the first stage, the change in volume is equal to the volume of water lost, but below a certain moisture content shrinkage for all practical purposes ceases. The order of movement with which Mr. Macey was concerned here is, of course, large compared with the dimensional changes undergone by rigid solids with change in moisture content that were discussed in the previous papers. In effect, the second stage referred to by Mr. Macey, in which volume change is very small, is the parallel to the behaviour of a rigid solid. The moisture content at which the first-stage shrinkage ceases varies considerably with the type of clay, and although it generally lies within the range of 8–13 per cent of water, it may be as high as 20 per cent. Under constant conditions of temperature and humidity, the rate of evaporation while shrinkage is taking place is constant, and very close to that of the free water surface, and it is only when the shrinkage ceases that the water surface retreats below that of the clay and evaporation is governed by diffusion through the pores and the reduced vapour pressure. Mellor explained the shrinkage behaviour of a clay by the supposition of continuous water films between the surface of the clay particles. During drying, the shrinkage of these films results in a change of volume equal to the volume of water lost, and this holds until the particles come into contact and shrinkage ceases. The thickness of the water films in a plastic clay appear from recent work to be of the order of, but probably less than, 1,000 A.

The last formal paper of the symposium was by Mr. F. R. Himsworth (Imperial Chemical Industries, Ltd.), on the setting and expansion of plasters, and thus dealt with a rather different topic. The expansion of plaster of Paris on setting has been utilized for a long time to give sharp castings, and this valuable property has been the subject of many investigations; nevertheless, the results obtained are still inconclusive. Calcium sulphate exists in three states of hydration, anhydrite, gypsum, and the lower hydrate, generally known as hemihydrate or plaster of Paris; but the system is not so simple as it appeared. The hemihydrate seems not to be a definite hydrate but to behave like a zeolite, the limits of composition being $CaSO_4$ and $3CaSO_4.2H_2O$. The linear expansion of plaster of Paris on setting varies widely, being as high as 1 per cent in some cases and less than 0·1 per cent for the special low-expansion types. The actual volume change in the system in the reaction

$$CaSO_4.\tfrac{2}{3}H_2O + \tfrac{4}{3}H_2O = CaSO_4.2H_2O$$

involves a reduction of about 4 per cent. The expansion must, therefore, be explained in some way by the mode of crystal growth. Gypsum formed from the hydration of the plaster of Paris crystallizes in the monoclinic system, but its crystal habit varies greatly according to the solution from which it crystallizes. Accelerators of set in general tend to give small rod-like or needle crystals and, though they do not greatly increase the number of nuclei formed, they increase the rate of growth. Retarders have more marked effects, in general, reducing the number of nuclei formed and also the rate of growth. The effect on crystal shape is generally to decrease the elongation and increase the size. Immediately after plaster is mixed with water and placed in the mould, there is a contraction in volume which stops as soon as the plaster begins to set and which, with retarded plasters, has a maximum value of about 0·15 per cent by volume. It is followed by an expansion which is roughly parallel to the rate of hydration. This behaviour can, Mr. Himsworth suggested, be explained by assuming that before the plaster acquires rigidity the crystals are free to move without restraint, and the true reduction in volume corresponding to the hydration process occurs. As soon, however, as a rigid structure is formed, unidirectional growth takes place under conditions of restraint and causes the apparent expansion. It may be noted in this connexion that there are theoretical difficulties in the assumption that growth of a crystal in a not completely confined space from its saturated solution can exert a pressure, and more direct experimental proof of such a process is still required.

In a short contribution to the afternoon session, Prof. Bernal commented that the fibrillar material revealed by electron-microscope studies of set cement suggests an analogy with certain other fibrillar materials such as tobacco mosaic virus, and with the behaviour they show when the concentration of their

solutions is changed. Developing this in a concluding address, Prof. E. K. Rideal observed that the fibrils would presumably behave as supermolecules and that the ratio of crystalline to amorphous regions, which is of much importance with polymers, would probably have a large influence on the properties of set cement. In the dehydration of zeolites, water can be removed without altering the external appearance, but holes may be left in the structure which would admit molecules of hydrocarbons. More information is needed about energy changes in such processes. Some alumino-silicates have a disk-like structure, and up to four layers of water molecules can be adsorbed between each disk. The system remains ordered if water is removed slowly, but on quick drying a disordered state may result. For an ordered system, the expansion on wetting is lateral for a water-rich system, and perpendicular for a water-poor system. The transportation of silt within a cement mass may also be of importance. Prof. Rideal referred in addition to work on diffusion gradients at crystal edges and the existence of mobile layers at crystal boundaries. It is possible that re-arrangement in a cement–water system may take place by osmosis, by transportation of silt, or by molecular movements.

F. M. L.

ANTHROPOLOGY ON THE CONTINENT OF EUROPE IN WAR-TIME

As has already been reported in *Nature* of May 18, p. 665, the Permanent Council of the International Congress of Anthropological and Ethnological Sciences visited England during April at the invitation of the Royal Anthropological Institute, and a most successful meeting was organised at Oxford by Sir John Myres, one of the joint secretaries of the Congress, to make arrangements for the next full meeting and to advance the work of the standing committees. The Royal Anthropological Institute took advantage of this gathering to invite the delegates to read short papers at informal meetings of the Institute in London, on the days immediately preceding and following the Oxford meetings, as a means of making better known in Britain and among the delegates themselves the progress made in anthropological science in their several countries since the outbreak of war brought international contacts to a stop. Eleven of the delegates accepted this invitation, and in addition two of the delegates delivered during their visits the Huxley Memorial Lectures for 1941 and 1945.

Mention should first be made of a full and illustrated account, given by Miss Johanna Felhoen Kraal (one of the Netherlands delegates) at an ordinary meeting on April 2, of the work of the Ethnographical Section of the Netherlands Institute for the Indies at Amsterdam, and particularly of the development of its policy in recent years under the late Prof. B. J. O. Schrieke, whose death in 1945 was so grievous a loss to Holland, to the East Indies and to anthropological science.

At the first of the special meetings, held on April 11, Prof. J. M. de Barandiaràn, who attended as a delegate of France, gave an illuminating account of Basque studies during the past ten years, mainly under the auspices of the Basque Research Institute, founded in 1921, which publishes the *Anuario de Etnologia* and the monthly *Eusko-Folklore*. The outbreak of the Spanish Civil War interrupted a number of important excavations at prehistoric sites in Spain which had already thrown much light on the origins of the Basque type so far back as the upper Palæolithic. Since 1937, the Institute's work had been confined to the French side of the frontier, and was on a reduced scale, though Prof. Barandiaràn had himself made some important discoveries suggesting a correlation between the distribution of ancient dolmens and cromlechs and the nomadism still practised in the same areas. Ethnographical work included studies of current folk-lore which seemed to have prehistoric parallels.

Prof. Edouard de Jonghe (Brussels) gave a very full and authoritative account of war-time progress in anthropological knowledge of the Belgian Congo. Most of the Belgian universities, museums, learned societies and scientific publications carried on throughout the German occupation, generally on a reduced scale, and resisted German influence with success: there were practically no cases of 'collaboration' among anthropologists. Prof. de Jonghe himself was deported to Germany just before the arrival of the Allies in Belgium in 1944. The four years isolation of the metropolis from its colony naturally concentrated the energies of research workers in Belgium upon the working up of material already collected. In the Congo, on the other hand, the War saw a great expansion of anthropological research, especially in the applied field. Prof. de Jonghe's detailed account of work published during the War included, under the head of prehistory, works by Lobar and de Jonghe (in collaboration), Bertrand, Van der Kerken, Bequaert (on the prehistoric collections of the Tervueren Museum), Cabus, Van Moorsel and Mortelmans.

On the physical side, interesting and important work was done on the practical problems of health and demography; but in the special case of the pygmies much fundamental research was also carried out—by Father Schebesta, with his associates Jadin and Gusinde, on the Bambuti pygmies (including blood-group studies); by Jullien, on the blood-groups of the Efe pygmies; by Father Schumacher, in a monumental work to appear shortly, on the Lake Kivu pygmies; and by Twisselmans on the pygmies of West Africa, especially the French Congo. In the linguistic field, a vocabulary of Alur was compiled by Father Van Neste, and a grammar of Chiluba by Father Willems. The use of Chiluba as the national tongue of the whole Belgian Congo had long been advocated by Prof. de Jonghe, and an important session of the Institut Royal Colonial Belge was devoted to discussion of this problem in 1944. A preliminary essay in the application of linguistic geography to the Bantu languages was made by Father de Boeck.

Among general ethnological works was De Cleene's excellent "Introduction à l'Ethnographie du Congo" (written from a rather functional point of view), and important monographs were produced on the Mongo, Basongo and Bakongo by Van der Kerken, de Beaucorps and Mertens. News was also given of the Institute's great investigation of the forms of slavery in the Congo. Juridical ethnology made great strides in the Congo during the War under the influence of Sohier, as had the systematic study of Congo art in Belgium under that of Prof. F. M. Olbrechts. After a short reference to recent studies by Van Reeth, Smets and others in the religions of the Congo and Ruanda, Prof. de Jonghe concluded with an interest-

ing account of recent studies of African mentality and philosophy by De Cleene (following Levy-Brühl) and Father Tempels. This lecture was a remarkable testimony to the success with which Belgian science has surmounted its war-time difficulties.

Prof. Olbrechts followed with a masterly exposiiton of the scientific approach to the study of Congo art which he has done so much to develop in recent years, distinguishing in the space of an hour, with a large number of excellent illustrations, all the important regional styles, together with the characteristic features by which they may each be identified. The extraordinary variety of styles, nearly all represented by examples of great vigour and high artistic merit, must have convinced all his hearers that the Congo is as fruitful a field for the student of art as any place in the world, and his forthcoming book on the subject will be awaited with great interest. He distinguishes three main zones: the western, which includes the rather decadent and lifeless art of the Lower Congo tribes, so long subject to European contacts, as well as the more southerly Bajokwe, with their far more vigorous and elaborate forms, and the Bapende, whose initiation masks are so arrestingly evocative of death; the central zone, in which are found the Bushongo, whose 'Court style' produced the superb portrait statue of the early seventeenth century Great Chief Shamba Bolongongo—now on view at the British Museum—and the nearby Bena Lulua, with their utterly different but equally fine sculpture; and the eastern zone, where the Baluba are pre-eminent. Particularly interesting among the Baluba figures is a series of half a dozen or more sculptures, now scattered among the museums of Europe, which are so precisely alike in feeling and in many details of style that Prof. Olbrechts believes them to be all from the same master hand. The successful synthesis of the ethnological and æsthetic approaches developed in this lecture may be thought highly suggestive for many other regions of the world.

On their return from Oxford on April 16, the delegates were honoured at a reception and lunch by the president and fellows of the Royal Anthropological Institute, after which they visited the British Museum for a special preview of the ethnographical section of the exhibition due to be opened a few days later. After tea with the Folklore Society, they attended the delivery of the Huxley Memorial Lecture, postponed from 1941, by the Abbé Breuil on "La Découverte de l'Antiquité de l'Homme et quelquesunes de ses Evidences", at a special meeting of the Institute in University College. In his memorable address, the Abbé Breuil first surveyed the growth and present state of man's knowledge of his early past, as it had been revealed by geological and archæological evidence, and then gave an account of his war-time field researches, bearing on this subject, on the sea beaches of Morocco, Portugal and South Africa, which has produced some significant correlations. He suggested the possibility that the South African Old Stone Age cultures may actually have been the ancestors of the comparable cultures of Western Europe, Asia Minor and India.

On April 16, the Rev. Pater W. Schmidt gave a short account of some of the effects of war upon anthropological study in the countries with which he has been specially associated—Switzerland and Austria—and in particular gave news of the well-known periodical *Anthropos*, of which he was the editor; its publication was transferred before the War from Vienna to Fribourg in Switzerland, and for various reasons is likely to remain there for some time to come. In spite of much war damage in Austria, the Natural History Museum at Vienna remains intact. After referring to the Pontificio Museo Missionario-Etnologico Lateranense at the Vatican, of which he is head, he concluded with an appeal for toleration by belligerent governments of the missionaries on whom native peoples depend for guidance, except where individual missionaries are clearly guilty of subversive activity. The wholesale internment, on grounds of nationality, of German and Italian missionaries by the Allies and of European missionaries by the Japanese produced serious ill-effects. He was glad to welcome a more liberal policy in the recent British decision to re-admit the German missionaries in India, Australia and New Guinea.

Prof. Gerhard Lindblom reported that scientific research in Sweden had been relatively little affected by the War. He surveyed shortly the work and publications of Sweden's famous museums: the Ethnographical Museum of Sweden at Stockholm, under his own direction; the Ethnographical Museum at Gothenburg, where Izikowitz has succeeded Kaudern; the Museum of Far Eastern Antiquities at Stockholm, under Karlgren; the Northern Museum at Stockholm, with its very active Lapp Department under Ernst Manker; and the State Historical Museum at Stockholm, rehoused in 1943, until lately under Arne's direction. On the teaching side, while interest in physical anthropology as such is still in its early stages, the study of general ethnology (now including more social anthropology) and of archæology is very well established in Sweden and has received further notable recognition during the past seven years; and Nordic ethnology is in a particularly flourishing condition, with important researches proceeding under Erixon, Svensson, Campbell and others. The most significant impression to be gained by a British audience from this admirable account was that of the very close and obviously successful interconnexion of the work of the museums and the universities in Sweden, with Lindblom, Karlgren, Izikowitz, Svensson, Lagercrantz and others dividing their energies between the two and helping to foster that integration of ethnological studies which has provided a firm basis for the expansion of activity and of public interest in those studies.

The first of three papers given on the evening of April 17 was by Prof. H. V. Vallois, who reported on the condition of physical anthropology in France during the war years under the three heads of the modern population of France, the coloured races of the French Empire, and fossil man. Systematic field-work in Brittany, the central massif, the Pays Basque and the north of France included an investigation of blood-group distribution which brought to light important regional differences, correlated with morphological characters. Other researches dealt with the Armenians and the Negroes resident in France, and a good deal of material gathered in Africa before the War was worked up and published. Studies of prehistoric remains included those of the Mesolithic men of Deventer (Pays-Bas) and le Cuzoul de Gramat (Département du Lot) and of the Neanderthal man of Rabat in Morocco. Prof. Vallois mentioned that the progress made in ethnology and prehistory was equally impressive, in spite of the very difficult working conditions for French science and the unwelcome attentions of the German police.

The address by Prof. G. H. Rivière, keeper of the Musée National des Arts et Traditions Populaires in Paris, on war-time research in the ethnography of France, should be well pondered, not without mortification, in Great Britain, where, but for the pioneer work of Dr. Peate in Wales, we have little indeed to set beside French achievements of recent years. A determined effort is being made by the French museums service, now under the control of the Ministry of Education, to record systematically the fast disappearing 'popular arts' of the country: the principal investigations undertaken during the War covered domestic furniture, rural architecture (for the purposes of reconstruction) and artisan techniques (including pottery, metallurgy, weaving, wood-working and basketry). Specimen files shown by Prof. Rivière for each of these researches gave a striking impression of the thoroughness, completeness and systematic efficiency without which such nation-wide investigations could scarcely be successfully undertaken. Lesser researches related to marionette theatres, folk-songs of Brittany, folk-tales, and to preparations for an ethnographical atlas of France and ethnographical monographs on particular French communities studied from all aspects. In 1945, the 557 provincial museums concerned with French ethnography were reorganised under a master plan providing for the division of their collections into carefully selected and well-spaced temporary exhibitions and larger reserve collections for scientific study. It may be hoped that full accounts of these developments will soon be available in Britain, for, without necessarily accepting so high a degree of centralization, we may gain much inspiration from French experience.

Prof. Sergio Sergi, of Rome, gave a short report, illustrated with photographs and diagrams, on the very important discoveries of human remains of Palæolithic age which he made at Saccopastore and Monte Circeio during the War, together with comparisons of the crania with those of other known specimens of Palæolithic man.

In physical anthropology, as in domestic ethnography, Great Britain lags at present far behind, and Prof. Tamagnini's talk on April 18, outlining remarkable progress made in Portugal, was fresh and salutary proof of this. After a short sketch of the history of anthropological studies in Portugal (with their emphasis from the beginning on the physical side), he summarized current research activities at Lisbon (under Heleno, de Vilhena and Barbosa Sueiro), Porto (Mendes Corrêa and Pires de Lima) and Coimbra (the speaker himself and Serra). Finally, he described his own Institute's very large and important statistical undertaking, in which the genealogical method is being applied to the study of blood groups and other characters among great numbers of families in the Department of Coimbra.

Prof. Valšik of Prague gave a very brief statement of the effect of German occupation upon Czechoslovak anthropology. All organised research in science had stopped, in default of any subservience to the Germans, and no publication had been possible. Physical anthropologists, such as himself, had mostly been engaged on the applications of science to health.

Lastly, Prof. Shevket Aziz Kansu's short but informative review of recent progress in Turkey showed that he and his colleagues were extremely active during the War, and that all branches of the science were being very successfully developed there.

On April 30, Prof. A. L. Kroeber, the United States delegate, delivered the Huxley Memorial Lecture for 1945 on "The Ancient Oikoumenê as an Historic Culture Aggregate", a memorable development of some aspects of his interpretation of cultural diffusion through the Eurasian land mass from the earliest times to the present.

W. B. FAGG

OBITUARIES

Prof. G. N. Lewis, For.Mem.R.S.

BY the death of Gilbert Newton Lewis in his seventy-first year the world has lost one of the greatest of its physical chemists. Since 1898, when he published his first paper with T. W. Richards on "Some Electrochemical and Thermochemical Relations of Zinc and Cadmium", until his last paper on "Paramagnetism of the Phosphorescent State" in 1945, he wrote some hundred and sixty-five papers on many branches of physical chemistry.

There are few branches of our science which 'G. N.' did not illumine by contributing something new and something fundamental to them. He was appreciated most widely abroad, not only for his concept of the static atom and the clear views on valency, notably the electron pair which that gave rise to, but also for his contributions to the thermodynamics and free energies of chemical substances and solutions, which introduced conceptions such as thermodynamic activity and fugacity now universally adopted. Many of the free-energy relationships were determined by means of electrode potentials—a field to which he devoted much attention. Lewis was the first (1933) to isolate deuterium, the heavy hydrogen isotope, to show its possibilities in the study of isotopic reactions, and to determine the physical properties of liquid and solid deuterium. His papers on acids and bases, on ultimate rational units and dimensional theory, give some indication of the wide interests of a gifted mind. During the last five years of his life he became deeply concerned with the problem of fluorescence, contributing some fifteen papers on this subject. His last papers, on phosphorescence and paramagnetism, were published last year.

The small volume printed in Berkeley to commemorate his seventieth birthday reveals how much America in its universities and industries is indebted to the school of which G. N. Lewis was the active and stimulating head. Among his many honours he received the Davy Medal of the Royal Society and was an honorary fellow of the Royal Institution. Some of us at Cambridge remember the summer when he paid us a visit, memorable for the enthusiasm which he imparted to all, and to the endless source of wonder and interest to his children which the differences in the countryside of California and Cambridge provided.

ERIC K. RIDEAL

Prof. F. Broili

FERDINAND BROILI, professor of palæontology and historical geology in the University of Munich, died on April 30, aged seventy-two. He was a student of v. Zittel and Rothpletz in Munich, visited the Permian of Texas in 1898 and there collected materials on which, during the next ten years, he published a series of important papers on reptiles and amphibia. He then wrote on the Permian Brachiopods of Timor

and on a variety of fossil reptiles. After the War of 1914–18, he became professor of palæontology and historical geology in Munich and director of the Bavarian State Palæontological Museum; in this capacity he added very greatly to the collections, which became the most important in Continental Europe. Broili then worked on Pterodactyls and other reptiles from the Sohenhofen Slate, until, as his collection increased, he published many papers on the fauna of the Devonian Slates of Gemünden. Later, in association with Schroeder, he wrote a long series of admirable papers on the vertebrates of the Karroo system of South Africa.

Broili thus produced a very great amount of most valuable work on invertebrates as well as on all the lower classes of vertebrates. All of it is clearly written, well illustrated, and contains important discussions of relationships and other general matters. In addition he produced new editions of the famous text-book, Zittel's "Grundzuge der Paläontologie", which are still of great practical use.

Broili was most generous in his reviews of the work of younger men, and in lending to other workers the materials of which he had charge; and he enjoyed the respect and friendship of palæontologists throughout the world.

D. M. S. Watson

Mr. J. A. Gardner

It was in the spring of 1911 that the Biochemical Society was founded by John Addyman Gardner, in association with other biochemists of that time. The recent announcement of his death will have been received with regret, but with feelings of admiration for a life so well spent.

An energetic native of Bradford, Gardner had a distinguished career at Oxford, obtaining first-class honours in the School of Natural Science in company with quite an array of distinguished Oxford chemists of his day. From Oxford he was appointed chemist to St. George's Hospital, London, a position he held until quite recently. He was for some time reader in physiological chemistry in the University of London and lecturer in organic chemistry at the London School of Medicine for Women. Always a keen research worker, his activities were for the most part conducted as biochemist at the Waller Physiological Laboratory. In this laboratory, which was at that time in the Imperial Institute at South Kensington, Gardner gathered round him a number of enthusiastic co-workers in the then rapidly spreading field of biochemistry.

Gardner was not alone in his desire to further the study of this subject, nor was he the only chemist to recognize the danger in those days of not keeping abreast of the knowledge of the medical aspects of chemical science. Prof. R. H. A. Plimmer, at that time reader in physiological chemistry at University College, was closely associated with Gardner in those activities, and jointly they called together a meeting which led to the foundation of the present Biochemical Society, which now has a membership roll of more than a thousand. Another pioneer was the late Prof. B. Moore, of the University of Liverpool, who with great foresight handed over to the new society the *Biochemical Journal*, which he was at the time publishing. The late Sir Arthur Harden and the late Prof. W. M. Bayliss gave their willing services as editors of the *Journal*.

Gardner was treasurer to the Society for more than twenty-two years. With great skill he nursed it through the difficult days of the First World War. He lived to see the Society with a world-wide membership including many eminent men of science, and a journal containing many important contributions to medical chemistry, and much of the development of our present-day knowledge of such substances as the vitamins and the sterols. It was to the last-mentioned field of study that much of Gardner's own work was directed.

The researches in which Gardner was concerned covered a wide field. He will be remembered with deep gratitude and affection by a number of co-workers for his kindly help and encouragement in their work. His researches on "The Origin and Destiny of Cholesterol in the Animal Organism", carried out in collaboration with a number of post-graduate workers, are among his best known. He clearly showed that cholesterol was widely distributed in living tissues, that it was strictly conserved and in the growing animal was not synthesized, but probably entirely derived from the phytosterol content of foods. This constant but small occurrence is perhaps explained as a source of the many essential sterols which since Gardner's earlier work have been brought to light; for we now recognize as chemically related to cholesterol a great variety of significant biochemical substances such as the cholic acids, the D vitamins, the sex and other hormones. With the late Prof. G. Buckmaster, Gardner published a number of observations on chloroform anæsthesia. The earliest work was on the chemical constitution of some of the terpenes carried out in conjunction with the late Dr. J. E. Marsh. Gardner's more recent work was on a variety of subjects of biochemical interest.

Gardner's contribution to science, whether it be his extensive research work, his help and encouragement to so many of his co-workers in biochemistry, or whether it be his share in the establishment of an important scientific society, constitutes a magnitude of endeavour which is given to few to accomplish.

G. W. Ellis

Dr. H. E. Wood

Harry Edwin Wood was born in Manchester on February 3, 1881, and died on February 27, 1946, at Mortimer, Cape Province, a few days after a heart attack. He studied physics at Manchester, Sir Arthur Eddington being one of his fellow students, and became an assistant to Sir Arthur Schuster. Before going to South Africa in 1906 to take up his duties as chief assistant at the former Transvaal Meteorological Observatory (now the Union Observatory) under R. T. A. Innes, he prepared himself by a period of work at the British Meteorological Office.

Soon after Wood's arrival, the Transvaal Observatory entered the astronomical field, Innes working with the 9-in. visual refractor, Wood concentrating mostly on the famous Franklin Adams star camera. This remained his principal instrument until the day of his retirement in 1941. Meanwhile he had succeeded Innes as Union Astronomer on January 1, 1928.

Wood was a diligent and careful observer, who used the instrument in his charge for those types of astronomical observation for which it was eminently suitable by virtue of its short focal-length, large field

of good definition and powerful light-grasp: discovery and measurement of minor planets, comets, variable stars and the preparation of star charts for the southern sky. For many years the responsibility for observing the minor planets which came to opposition in southern declinations rested almost entirely on his shoulders. He discovered several of these elusive objects and computed the first orbits for many of them, as he did in the case of comets. A few days before his retirement he computed the first orbit for the bright comet discovered by Mr. de Kock, using three of his own observations obtained with the Franklin Adams camera on three successive nights. Notwithstanding this short time interval, his orbit proved to be a remarkably close approximation, thus demonstrating his powers as a careful observer and computer.

Though mainly a photographic observer, Wood also took a regular share in visual observing of occultations of stars by the moon, phenomena of Jupiter's satellites, micrometer observations of comets, etc. He was also in charge of the Wiechert seismograph at the Union Observatory over a period of many years, and made a careful study of the earth tremors caused by mining operations on the Witwatersrand.

Wood was a gifted, clear and interesting lecturer; for some time he gave the lectures on astronomy at the University of the Witwatersrand, which in 1937 conferred the honorary degree of doctor of science on him. After his retirement he prepared a series of radio talks on astronomy for the schools.

During the War of 1914–18 he served with the Union Defence Force and took part in the campaign in East Africa. There he contracted malaria, with serious results to his health in later life. Wood married a former Manchester fellow student. His widow survives him; they had no children.

W. H. VAN DEN BOS

WE regret to announce the following deaths:

Prof. B. H. Bentley, emeritus professor of botany in the University of Sheffield, on June 24, aged seventy-three.

Sir George Julius, chairman of the Commonwealth Council for Scientific and Industrial Research, Australia, aged seventy-three.

NEWS and VIEWS

Canadian Honours List

THE following names of scientific workers and others associated with scientific affairs appear in the honours list issued on the occasion of Dominion Day, July 1, in Canada:

C.M.G.: Dr. Alexander T. Cameron, chairman of the Fisheries Research Board, Winnipeg; Dr. D. B. Finn, deputy minister of fisheries, Ottawa.

C.B.E.: Dr. E. S. Archibald, director of the Experimental Farm Service, Department of Agriculture, Ottawa; Prof. C. W. Argue, professor of biology, University of New Brunswick; Prof. H. C. Bazett, of the Banting and Best Institute, Toronto; Dr. J. G. Bouchard, assistant deputy minister, Department of Agriculture, Ottawa; Dr. R. D. Defries, director of the Connaught Laboratories, Toronto; Mr. A. Hunter, chairman of the Standing Committee on Nutrition, Department of National Defence, Toronto; Dr. Otto Maass, of the National Research Council, Ottawa; Mr. J. H. Parkin, of the National Research Council, Ottawa; Dr. J. M. Swaine, formerly director of Science Service, Department of Agriculture, for services as a member of the Agricultural Supplies Board, Ottawa; Mr. W. B. Timm, director of the Mines and Geology Branch, Department of Mines and Resources, Ottawa; Mr. J. M. Wardle, director of the Surveys and Engineering Branch, Department of Mines and Resources, Rockcliffe, Ontario.

Royal Society of Edinburgh

THE following have been elected honorary fellows of the Royal Society of Edinburgh:

Foreign honorary members: Prof. H. G. Backlund, emeritus professor of geology, University of Uppsala; Prof. J. Hadamard, formerly professor of mathematics, Collège de France, and l'École Polytechnique, Paris; Prof. J. H. Hildebrand, professor of chemistry, University of California, Berkeley; Prof. S. A. S. Krogh, professor of animal physiology, Zoophysiological Laboratory, Copenhagen; Prof. E. O. Lawrence, professor of physics, University of California, Berkeley; Prof. E. D. Merrill, professor of botany, Harvard University; Prof. J. H. F. Umbgrove, professor of geology, Technische Hoogeschool, Delft.

British honorary members: Prof. E. D. Adrian, professor of physiology, University of Cambridge; Prof. F. T. Brooks, professor of botany, University of Cambridge; Sir James Chadwick, professor of physics, University of Liverpool; Prof. P. A. M. Dirac, Lucasian professor of mathematics, University of Cambridge; Prof. G. H. Hardy, emeritus professor of pure mathematics, University of Cambridge; Sir George Simpson, formerly director of the Meteorological Office, London.

The Keith Prize (1943–45) was presented at the meeting on July 1 to Dr. W. L. Edge, University of Edinburgh, for his work in geometry, particularly for his papers published in the *Proceedings* of the Society within the period of the award; and the Neill Prize (1943–45) jointly to J. G. Carr, Institute of Animal Genetics, University of Edinburgh, for his contributions to our knowledge of tumour viruses in animals; and to Dr. Ethel D. Currie for her paper on "Growth Stages in some Jurassic Ammonites", published in the *Transactions* of the Society within the period.

Romano-British Silver Hoard in Suffolk

A REMARKABLE find of Roman silver plate of a highly elaborate character at Mildenhall, Suffolk, has recently been reported in the Press. The discovery was made by Mr. Sidney Ford, of West Row, Mildenhall, who, while ploughing recently, turned up a circular silver dish which is more than two and a half feet in diameter and weighs some 224 ounces. Further exploration of the ground with a spade brought to light thirty-three more pieces of plate, all of silver and most of them elaborately embossed and ornamented. These include a second large circular dish,

slightly smaller than the first, two smaller dishes, embossed with figures, several ornamented bowls, a pair of standing cups, a large fluted bowl with a pentacle as ornament at its centre, a number of detached handles, spoons, small cups and ladles, and a convex ornamented cover with the figure of a child as handle. The large circular dish is a remarkable piece on æsthetic grounds, apart from its size and weight. It is a characteristic example of Romano-British style of the later period of the Roman occupation, crowded with exuberant figures executed with great technical skill (see *Illus. London News*, June 29). There are many points of interest connected with this find which no doubt will give rise to much discussion in the future. It is possible to mention here only one—that of the dating. It has been suggested that the hoard may have been buried about the end of the third century of our era, that is, about A.D. 300, but a later date by some fifty years seems possible. Apparently this find belongs to that class which consists of household goods of villas buried when in danger from raiders. But according to the evidence of coins from such hoards, this practice did not begin until near the middle of the century and came to an end when in A.D. 367 Romano-British villa life in East Anglia suffered its final blow at the hands of barbarian sea-raiders.

Rayon Technology at Manchester

In accordance with their declared policy of providing financial assistance for the development of technical education in subjects of importance to the British rayon industry, Messrs. Courtaulds, Ltd., last week announced a gift of £60,000 to the Manchester College of Technology, which is also the Faculty of Technology in the University of Manchester. The money will for the most part be used for completely re-equipping the two Departments of Textile Industries and Textile Chemistry with up-to-date machinery and apparatus for training and research in rayon technology. The gift is particularly opportune because building is about to be resumed on the considerable extensions to the College which were started before the War and in which space had already been earmarked for rayon development, especially in reference to research. These plans can now be brought to fruition much more completely and more quickly than would otherwise have been possible.

The past decade has witnessed a notable increase in the number and variety of man-made fibres available to the textile industries. Of equally great importance, however, are the great strides that have been made in the study of their behaviour and properties, and in the growing appreciation of their independent significance in the textile economy as a whole. This has led, on one hand to the opening up of new fields of application, and on the other to a complete re-consideration of the orthodox sequence of industrial operations by which these materials in their different forms are commonly spun, woven, dyed and finished. The fundamental principles of fibre treatment are for the most part applicable to all textile materials, whatever their origin; but in the application of these principles, so far as the rayons are concerned, there are now in prospect more radical departures from orthodox practice than have been made hitherto. As a result of Messrs. Courtauld's gift, the Manchester College of Technology will be able not only to demonstrate the latest types of machinery and process but also play a much larger part, by experiment and research, in contributing to their further development.

Education in the Royal Air Force

The Air Council has now approved the formation of an Education Branch of the Royal Air Force in place of the civilian Educational Service that has existed hitherto. Education officers will now become part of the Royal Air Force itself, instead of being members of a civilian auxiliary service. The R.A.F. Education Branch, which will consist of commissioned officers only, will be constituted on the same broad lines as other branches of the Royal Air Force. The Branch will be organised on a predominantly short-service basis, provision being made for a percentage of short-service officers to be granted permanent commissions. Vacancies in the permanent cadre will normally be filled from the ranks of short-service officers, but officers with qualifications of outstanding value to the R.A.F. may exceptionally be appointed direct to permanent commissions. The intention is that officers should be appointed to short-service commissions, for a period of five years on the active list followed by four years on the reserve, and that they will enter at an average age of twenty-five in the rank of flying officer, normally after having had some civil teaching experience.

Service in the Education Branch of the Royal Air Force will be recognized by the Ministry of Education for determining the correct incremental position on the Burnham scales of salary of teachers who afterwards enter or return to civilian teaching employment. Further, the period of the short-service engagement of officers of the Education Branch who have been in contributory service under the Teachers (Superannuation) Acts will reckon as contributory service towards any ultimate award of pension under those Acts. It is hoped that it will be possible to make similar provision for short-service officers who were not in contributory service before entering the Branch. Candidates for appointment to the Branch must be in possession of a full degree of a university or an equivalent qualification obtained by examination, and the possession of first- or second-class honours will normally be a requirement for appointment to a permanent commission. A detailed announcement will be made as soon as possible with regard to the conditions of entry to and service in the new Branch, together with information regarding the conditions of assimilation of existing members of the R.A.F. Educational Service.

International Academy of the History of Science

The activities of the International Academy of the History of Science were suspended during the War. Prof. Aldo Mieli, the permanent secretary, is not at present able to leave Buenos Aires, and it has not yet been possible to resume publication of *Archeion*, the journal of the Academy. It has been decided, however, to hold a congress at Lausanne in the summer of 1947. All interested in the subject will be welcome, and the following provisional measures have been taken: J. A. Vollgraff (Roodbortsstraat 17, Leyden, Holland) is acting as secretary-treasurer, and Prof. P. Brunet (Hotel Nêvers, 12 Rue Colbert, Paris 21ème) as archivist and librarian. Prof. Arnold Reymond, of Lausanne, was elected president at the last meeting and will preside at the next. A corrected list of the surviving members of the Academy is being compiled. Each individual member and each national group is urgently requested to send the necessary information either to Prof. Brunet or to M. Vollgraff. Suggestions for the replacement of

both executive and corresponding members who have died since 1938 will be welcomed. Prof. Brunet further wishes to receive from members copies of books and brochures published by them since 1939, together with a note both of their own activities and that of their national group during the intervening period. Obituary notices of those who have died, together with photographs, are also desired.

Mineral Resources and Exploration

In his presidential address delivered on May 16 before the Institution of Mining and Metallurgy, Mr. G. F. Laycock reviewed the general position as regards the probable world resources of some of the more important metals, the prospects of finding further supplies and the methods employed in the search for new ore-bodies. For many years past few discoveries of important deposits have been made, apart from gold and iron. In Canada, for example, 84 per cent of the 1942 production was obtained from mineral areas discovered before 1920, and only 5 per cent from those discovered since 1930. Except in the U.S.S.R., the position is probably much worse in most other countries. Obviously, to a very large extent we are to-day living on our mineral capital. While it is clear that the era of surface prospecting has entered the phase of diminishing returns, there is every probability that many valuable ore-deposits, which do not outcrop or even closely approach the surface, still remain to be discovered. Mr. Laycock emphasizes the following suggestions: (1) Intensive research should be directed towards the development of new or improved methods of geophysical exploration with a view to the elimination of the uncertainties and weaknesses of existing methods. (2) Operating companies must be officially encouraged, for example, by tax reliefs, to carry out intensive prospecting for new sources of ore in and around existing workings by means of geological, geophysical and diamond-drilling methods. (3) Exploration companies should be formed to investigate potentially promising virgin areas where old-fashioned prospecting methods are useless by themselves; prospecting rights must be granted over wide areas, and the very considerable expenses of such large-scale operations should be allowable for taxation purposes as deductions against any future profits. Mr. Laycock predicts that with such stimulation and governmental assistance the present unsatisfactory position is likely to be greatly improved by the discovery of important concealed deposits.

Chemical Engineering as a Profession

There is a very marked expansion at the present moment of those industries which are mainly concerned with some chemical process for their development. There is so great a demand for chemical engineers that the Institution of Chemical Engineers, in conjunction with the Institute of Petroleum, the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers Association, addressed a memorandum to the Government, directing attention to this remarkable development, and at the same time emphasized the very great shortage of trained chemical engineers in Great Britain compared, for example, with that existing in the United States. The number of students each year studying for a degree in chemical engineering is at present about forty in Britain, compared with three thousand in the United States. To meet the situation, the Government is proposing to establish courses in chemical engineering for those who already have a chemistry, physics or engineering degree, as a short-term policy in order to train chemical engineers to meet this demand, which at the present moment is more active on the plant-manufacturing side, owing to the fact that many proposed improvements and developments have had to be postponed until after the War. While, therefore, at the moment there is a special demand for men to design and erect this equipment, there are also big requirements for chemical engineers in the industries using plant. The fourth year of the degree course recommended by the Institution of Chemical Engineers roughly corresponds to the post-graduate courses now being organised. The exact training which the students receive will depend, of course, to some extent on their previous knowledge, and will be designed to enable them to approach the chemical engineering course proper with sufficient background in the general principles of chemistry and mechanical and electrical engineering.

Recent Earthquakes

During May 1946 several strong earthquakes occurred in various parts of the earth. Many of these had their epicentres under the sea and thus fortunately did little material damage. These include the shocks of May 3, south-east of New Guinea; May 8, west of Sumatra; May 9, Gulf of California; and May 15, off coast of Southern Mexico (United States Coast and Geodetic Survey). The shock of May 21 did damage on Martinique, West Indies. Its epicentre has been determined on the basis of instrumental reports from eleven observatories by the United States Coast and Geodetic Survey as being lat. 14·2° N., long. 60·8° W., and origin time 09 h. 16·6 m. G.M.T. Two strong shocks at 02·30 hr. and 04·40 hr. on May 30 with epicentre in Canton Valais, Switzerland, did some damage to a church and houses at Bex. Houses were badly shaken at Berne, but no damage was done. In addition to the shocks of May 3 and 8, Mr. E. W. Pollard in the Isle of Wight recorded a smaller distant shock on May 11.

Early on Saturday, June 1, a severe earthquake occurred in the region of Mush, eastern Anatolia, Turkey, about 480 miles south-east of Ankara. Severe damage is reported to include 215 houses destroyed; 590 people are said to have been killed and about 100 injured.

Films in Microbiology and Protistology

Films made under the direction of Dr. Comandon by the Département de Cinémicrographie, Institut Pasteur, Garches, S. et O., will be brought to Great Britain shortly by M. Pierre de Fonbrune. They include those reviewed in the *Lancet* (Jan. 11, 1946, p. 111) and in the *British Medical Bulletin* (4, No. 1, 72; 1946); also films on *Amœba verrucosa* and *Lankesterella* and on mitosis. They are silent films on 35 mm. stock with captions in French. A selection of these films will be shown in London by the British Council on July 15, at 5 p.m. A limited number of seats is available and will be allotted in rotation on application to the British Council, 3 Hanover Street, London, W.1.

Study Group on Special Librarianship

The Association of Special Libraries and Information Bureaux is proposing to repeat the successful experiment of last year of organising a study group on special librarianship in collaboration with the Library Association. This will be held at Chaucer House, London, during August 12–17. There will be lectures in the mornings, and in the evenings talks and discussions on special topics, while in the afternoons it is hoped to arrange visits to a number of special libraries. Full details and application forms can be obtained from the Director, ASLIB, 52 Bloomsbury Street, W.C.1.

University of London

Dr. A. D. Ross has been appointed to the University chair of civil engineering tenable at King's College from October 1; since 1935 he has been lecturer in the Department of Civil and Mechanical Engineering at the College.

Mr. S. H. Beaver, lecturer in geography at the London School of Economic and Political Science, has been appointed to the Sir Ernest Cassel readership in economic geography tenable at the School.

The degree of D.Sc. of the University has been conferred on: Mr. J. F. Kirkaldy (King's College); Mr. S. Maulik (Imperial College of Science and Technology); Mr. B. S. Rao (University College); Mr. T. Small (King's College); Mr. A. R. Collar (external student).

Institution of Electrical Engineers: Awards

The Council of the Institution of Electrical Engineers has made the following awards of premiums for papers read, or accepted for publication, during the session 1945–46: *Institution Premium*, Dr. F. C. Williams. *John Hopkinson Premium*, J. F. Coales, J. C. Calpine, and D. S. Watson. *Non-Section Premiums*, R. H. Coates and B. C. Pyle (Ayrton Premium); J. C. Read (Llewellyn B. Atkinson Premium); F. Ashworth, W. Needham, and Dr. R. W. Sillars (Extra Premium). *Installations Section Premiums*, R. Grierson and Forbes Jackson (Crompton Premium); Dr. A. J. King (Swan Premium); J. C. Macfarlane, Dr. J. W. Macfarlane, and W. I. Macfarlane (Extra Premium). *Measurements Section Premiums*, Dr. A. L. Whiteley (Silvanus Thompson Premium); C. G. Garton (Mather Premium); Dr. A. Fairweather (Extra Premium). *Radio Section Premiums*, Dr. H. G. Booker (Duddell Premium); E. C. Cherry (Ambrose Fleming Premium); C. F. Booth and F. J. M. Laver (Extra Premium); R. J. Clayton, Dr. J. E. Houldin, Dr. H. R. L. Lamont, and W. E. Willshaw (Extra Premium); Dr. R. A. Smith (Extra Premium); E. C. S. Megaw (Extra Premium); O. L. Ratsey (Extra Premium); R. J. Dippy (Extra Premium); Dr. N. R. Campbell and V. J. Francis (Extra Premium). *Transmission Section Premiums*, Dr. L. G. Brazier (Sebastian de Ferranti Premium); A. G. Ellis (John Snell Premium); P. J. Ryle (Extra Premium). *Fahie Premium*, F. C. McLean and F. D. Bolt. *Paris Exhibition* (1881) *Premium*, J. S. Pickles and W. H. Wills. *Webber Premium*, Dr. D. H. Parnum. *Willans Premium* (awarded triennially by the Institution of Electrical Engineers and the Institution of Mechanical Engineers), R. W. Biles and G. W. Maxfield, for their paper on "Standards of Performance of Generating Plant based on Five Years Operating Data".

Announcements

Dr. John A. Fleming, director since 1935 of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, has retired, but will remain at the Institution temporarily as adviser in governmental and international scientific relations. It will be recalled that Dr. Fleming was awarded the Charles Chree Medal for 1945 of the Physical Society of London (see *Nature*, December 1, 1945, p. 658). Dr. Fleming will be succeeded by Dr. M. A. Tuve, chief physicist of the Department.

The Institution of Chemical Engineers is establishing two bursaries, each of £100 a year, to assist students to obtain a bachelor's degree in chemical engineering. Candidates must have reached the higher school certificate or intermediate B.Sc. or equivalent standard; they may have spent a period in industry or in H.M. Forces. The bursaries will be tenable for three years. Applicants should be British subjects by birth. Applications should be addressed to the Joint Honorary Secretaries, Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1, by whom they must be received not later than August 1.

The Trustees of the Busk studentship in aeronautics, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 while flying an experimental aeroplane, have awarded the studentship for the year 1946–47 to Richard Peter Boswell, of Hawker Aircraft, Ltd.

The four Exhibition Galleries of the Imperial Institute, London, have been re-opened to the general public from 10 a.m. until 4.30 p.m. on weekdays. There is a display of Empire films in the cinema of the Institute each day at 3.30 p.m.

The Present Question Conference (Secretariat, 37 Middleway, London, N.W.11) will meet at University College, Exeter, during August 20–27. The purpose of this Conference is to consider in a practical way various approaches to the question: "Is the present chaos caused by lack of scientific planning, or by failure to recognize the reality of Spirit? The answer may be found through a deeper understanding of the nature of man." It is believed that an experimental approach will prove of value in obtaining a synthesis between the opposing points of view of science and religion. The announcement is signed by, among others, Dr. W. R. Matthews, Dr. Stephen Neill and Prof. A. D. Ritchie.

A useful 64-page pamphlet by G. A. Campbell and T. F. West entitled "The Truth about D.D.T." has recently been issued by Findon Publications, Ltd. (1*s*.). The original discovery of this compound is traced from when it was achieved in Basle, many years ago, up to its most recent applications, whether incorporated in dusts, spray fluids or mixed with paints, distemper, etc. For those wishing to know the essential facts concerning this insecticide and its potentialities, this simply written account will give the desired information.

In the graph accompanying the communication entitled "Dielectric Behaviour of 'Polythene' at Very High Frequency" by J. G. Powles and W. G. Oakes in *Nature* of June 22, p. 840, the wave-length scale has inadvertently been shifted to the left; the right-hand end of the scale (1 cm.) should be vertically below $3\cdot33 \times 10^{10}$ on the frequency scale.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

New Synthetic Contact Insecticides

SOME laboratory experiments have been made to estimate the relative toxicity to body lice and to bed bugs of several new synthetic insecticides which have been produced on an industrial scale during recent years in Britain, Germany and the United States. They comprise the following types: (1) D.D.T.; (2) certain analogues of D.D.T.; (3) 'Gammexane'; (4) chlorphenyl chlormethyl sulphone.

The various substances were tested as sprays in mineral oil solution and also (rather less accurately) as dry powders diluted with kaolin. Fuller details of the methods will be published in due course. In the accompanying table, the samples are compared by their median lethal concentrations for the two insects, under the conditions of the experiments. These results call for certain comments.

	Median lethal concentrations (%)			
	Oil spray		Dust	
	Lice	Bugs	Lice	Bugs
1. D.D.T.	0·3	0·53	0·4	0·5
2a. 'Lauseto' mixture	1·2	—	—	—
2b. Difluor diphenyl trichlorethane	1·4	5·0	1·2	3·0
2c. Dichlor diphenyl dichlorethane	0·9	1·2	2·4	1·0
3. 'Gammexane'	0·016	0·051	0·005	0·015
4. Chlorphenyl chlormethyl sulphone	0·1	0·2	0·2	0·6

(1) D.D.T. There is already a considerable amount of information about this insecticide, so that it may serve as a standard for comparison. The material used was pure *pp*-D.D.T. (m.p. 108° C.) obtained from the Chemical Defence Experimental Station, Porton.

(2) D.D.T. Analogues. (*a*) 'Lauseto'. In Germany, an insecticide of this name was used during the War to impregnate clothing against body lice, using an emulsion method. A sample of the active principle was tested. This is prepared[1] by the reaction of benzene with chlorbenzene and chloral, so that, as well as D.D.T., it probably contains 2,2-*bis*-(phenyl)1,1,1-trichlorethane and 2-phenyl, 2-chlorphenyl, 1,1,1-trichlorethane. It was claimed that this mixture, which is a viscous brown liquid containing excess reactants, is easier to emulsify than D.D.T. As can be seen, it is only about a quarter as toxic as pure D.D.T. to lice.

(*b*) 'Gix'. This is another German insecticide, the active constituent being 2,2-*bis*(*p*-fluorphenyl)1,1,1-trichlorethane (m.p. 45° C.), a sample of which was supplied by the Geigy Co., Ltd. It was claimed by workers at the I. G. Plant Protection Laboratory at Hochst that this compound is more effective than D.D.T. to a number of pests, including gypsy moth, brown tail moth, grain weevil, roaches, red scale and houseflies. According to Kilgore[2], however, their test methods are somewhat suspect. This 'fluorine-D.D.T.' is certainly much less toxic than D.D.T. to lice and bed bugs.

(*c*) 'D.D.D.' or 'T.D.E.'. The compound 2,2-*bis*(*p*-chlorphenyl)1,1-dichlorethane (m.p. 111° C.) has been shown to be about as toxic as D.D.T. to mosquito larvæ in laboratory tests[3]. It has been produced commercially in the United States with the claim that it is of the order of toxicity of D.D.T. to insects and decidedly less toxic to mammals. Towards lice and bed bugs it appears to be about a third as insecticidal as D.D.T.

(3) 'Gammexane'. Some pure gamma hexachlorocyclohexane (m.p. 112° C.) was obtained from Imperial Chemical Industries, Ltd. The extremely high insecticidal power of this substance, especially towards lice, is noteworthy.

(4) 'Lauseto Neu'. The active principle of this German product represents a new type of insecticidal compound; it is chlorphenyl chlormethyl sulphone:

This compound is a crystalline solid (m.p. 118° C.), odourless and apparently of the same order of permanence as D.D.T. A sample was received from the Public Health Division of the British Control Commission for Germany. It was found to be more toxic to lice and bed bugs than D.D.T., but its use is limited by low solubility in refined mineral oils (about ½ per cent). The Germans used it in the form of a powder and also as dispersions and emulsions: they were in any event so short of oil during the War that kerosene could not be spared for insecticides.

The object of this communication is to direct wider attention to these new insecticides. Considerably more research must be done before sufficient data exist for choosing the most suitable for any particular use.

J. R. BUSVINE

Entomology Department,
London School of Hygiene and Tropical Medicine.
June 5.

[1] Kilgore, L. B., *Soap*, 21 (12), 138 (1945).
[2] Kilgore, L. B., *Soap*, 22 (3), 122 (1946).
[3] Deonier, C. L., and Jones, H. A., *Science*, 103, 13 (1946).

Cause of Physiological Activity of 'Gammexane'

IT has been suggested by Slade[1] that the physiological activity of γ-hexachlorocyclohexane, the active constituent of the insecticide 'Gammexane', is due to its antagonism towards the essential metabolite *i*-inositol, which is considered to have the same spatial configuration. Kirkwood and Phillips[2] have recently shown that for the Gebruder Mayer strain of *Saccharomyces cerevisiae* this is in fact the case, since the γ-isomer has a marked inhibitory effect on the growth of the organism, and the inhibition is overcome by the addition of more *i*-inositol to the medium. The other three isomers of hexachlorocyclohexane are but slightly inhibitory, and excess *i*-inositol is without effect.

We had for some time been working with *Nematospora gossypii*, an ascomycete known to require exogenous *i*-inositol[3], and had observed a similar effect with the γ-isomer. Our findings, which support those of Kirkwood and Phillips, bear out the original suggestion of Slade. As an example, the results of one experiment are given:

Medium used: Glucose, 2 gm.; K_2HPO_4, 0·5 gm.; $MgSO_4,7H_2O$, 0·25 gm.; casein hydrolysate ('vitamin free'), to supply 0·25 gm. nitrogen; biotin (Glaxo), 0·1 mgm.; agar, 2 gm.; per 100 ml. medium. Cultures incubated at 30° C. for 7 days.

Wt. of *i*-inositol per 100 ml. medium	Wt. of mycelium, from pairs of plates, dried at 100° C. without added γ-isomer	with γ-isomer added to solubility limit
2 mgm.	90 mgm.	20 mgm.
4	122	42
6	154	74
8	178	132
10	190	180

With the β-isomer, no inhibition was found, but a very slight effect was noted with the α-isomer in a medium with a low *i*-inositol content. In a few tests in which hydrolysed gelatin was used as a source of nitrogen, the inhibitory effect of the γ-isomer was rather more marked.

There is some uncertainty concerning the solubility of γ-hexachlorocyclohexane in aqueous media. The American workers quote a figure of 60 μgm. per ml., whereas Slade gives 10 μgm. In our experiments, 10 mgm. of the compound, dissolved in 1 ml. ethanol, were added to 100 ml. of the medium. In view of the uncertainty as to the actual amount of the compound dissolving in the medium, and since complete inhibition of growth was not observed, the molecular inhibition ratio (McIlwain[4]) has not been calculated.

We are grateful to Messrs. I.C.I. (General Chemicals), Ltd., for generous gifts of the α-, β- and γ-isomers of hexachlorocyclohexane.

H. W. BUSTON
S. E. JACOBS
A. GOLDSTEIN

Department of Botany,
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South Kensington,
London, S.W.7.
May 28.

[1] Slade, Hurter Memorial Lecture, *Chem. and Ind.*, 314 (1945).
[2] Kirkwood and Phillips, *J. Biol. Chem.*, 163, 251 (1946).
[3] Buston and Pramanik, *Biochem. J.*, 25, 1656 (1931).
[4] McIlwain, *Brit. J. Exp. Path.*, 23, 95 (1942).

Loss of Thiamin During the Baking of Bread

WE have just received the published account[1] of a symposium on "Factors Affecting the Nutritive Value of Bread as Human Food". An important issue not touched upon by the various speakers, but raised during discussion, concerned the loss of thiamin during the baking of bread. Two speakers expressed the view that in baking bread the loss of vitamin B_1 is slight. There are published data in support of this statement, but also a great deal of evidence to the contrary (see review by Holman[2]). The idea that little thiamin is lost during baking is surprisingly widespread, but is completely erroneous so far as breads made from very high extraction meals are concerned.

Using a thiochrome assay method[3], we have investigated the thiamin content of South African wheat-meals and the so-called 'Standard' bread introduced into this country early in the War. The bread is made from 'No. 1 Unsifted meal', originally of 95 per cent extraction but now approaching 100 per cent extraction. The mean values obtained in our survey are given below, together with some published British values for purposes of comparison.

Meal	Extraction (per cent)	Thiamin content (μgm./gm.)* Meal	Bread	Calculated loss of thiamin during baking (per cent)
British[4]	85	3·07	1·85	14·8
British[4]	85	3·00	1·83	16·8
British[4,5]	80	2·49	1·50	15·0
South African[6]	95	3·50	1·79	27·8

* Calculated to 11 per cent moisture for flour and 37 per cent moisture for bread.

It will be seen that South African 'Standard' bread, made from 95–100 per cent extraction meal, contains no more thiamin than the British 85 per cent extraction loaf. Yet the original meal is far richer in thiamin. On the assumption that the calculated loss of thiamin is entirely due to baking, and disregarding the other ingredients used in the loaf, it is clear that the destruction of thiamin in 'Standard' bread is almost twice as great as it is in the breads of lower extraction flours.

The greater loss of thiamin from high extraction wheatmeal may be attributed to the longer time required for baking. 'Standard' bread

requires 40–50 minutes baking, and often a little extra time is given it, in an attempt to prevent the subsequent development of 'rope'—a not infrequent occurrence in our climate. The oven temperatures are, if anything, a little lower for 'Standard' bread than for white bread which, however, requires only about thirty minutes baking. One is therefore led to the conclusion that it is the longer period of heating which brings about the greater degree of destruction of thiamin. Published data support this contention[7,8].

It follows from our findings that, while 'Standard' bread has some advantages over an 85 per cent extraction loaf, increased thiamin content is not one of them.

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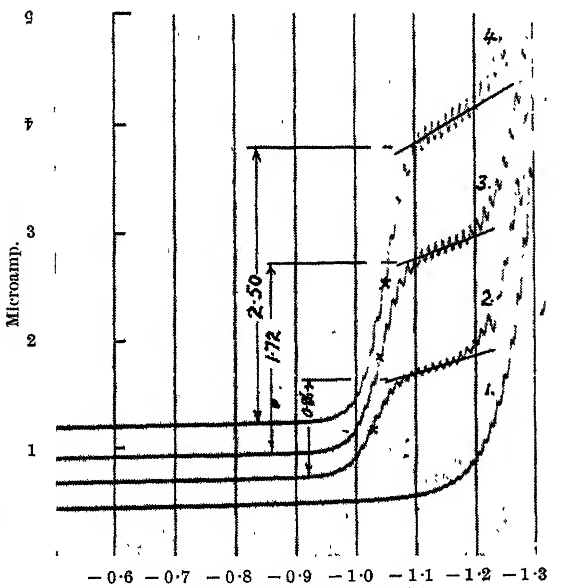
Polarographic Behaviour of Adenine

WORK in this laboratory on differences in mechanism between normal and malignant cells has shown the great need for improved methods of analysis and characterization of nucleic acids. Investigations which I began before the War indicated to me the value of the polarograph as an analytical tool in the study of inorganic cell constituents, and there was reason to believe that it had great possibilities in the organic field. Excellent accounts of general polarographic methods are now available[1,2].

Accordingly the behaviour of certain purine and pyrimidine bodies at the dropping mercury electrode was studied. Pech[3] had stated that compounds belonging to the purine group were not reducible at this electrode, with the exception of uric acid, which was reducible only after prolonged exposure to air in solution with lithium carbonate.

The present investigations show quite definitely that adenine, adenosine, adenylic acid and an adenine-cytosine dinucleotide are all reducible at the dropping mercury cathode and give well-defined diffusion currents or 'polarographic waves' when in solution in 0·1 *N* perchloric acid, and also in buffer solutions of perchloric acid and potassium perchlorate of similar concentration. Under the same conditions, no reduction occurs and no waves are obtained for guanine, guanosine, or guanylic acid, or for cytidine or cytidylic acid, or for uracil. Pure cytosine was not available and was not tested, but for reasons given later in connexion with adenine, it seems unlikely that cytosine will be reducible if cytidine and cytidylic acid are not. Thymine was not available for test, but as 5-methyl uracil it is unlikely to be reduced when uracil itself is not.



POLAROGRAMS OF ADENINE IN 0·1 *N* PERCHLORIC ACID AT 25° C., SHOWING CONSTANCY OF i_d/C AND VARIATION OF $E_{1/2}$ WITH CONCENTRATION. CONCENTRATIONS OF ADENINE: (1) ZERO, (2) $0·50 \times 10^{-4}$ *M*. (3) $0·99 \times 10^{-4}$ *M*, (4) $1·48 \times 10^{-4}$ *M*. THE POINTS MARKED WITH A CROSS INDICATE HALF-WAVE POTENTIALS. THE CURRENT ZERO HAS BEEN SHIFTED FOR EACH TRACE

An extensive study was made of the reduction at the dropping mercury cathode of adenine, adenosine and adenylic acid. In all three cases the diffusion current (i_d) was proportional to concentration (C) over the ranges investigated, C being throughout of the order of 10^{-4} *M*. For adenine in concentrations between $0·50 \times 10^{-4}$ *M* and $1·96 \times 10^{-4}$ *M* the value of i_d/C was 17·0 μA./millimol. per litre for the particular capillary used and at 25° C. The value of i_d/C for the other compounds decreases with increasing complexity, that is, in the order adenine, adenosine, adenylic acid, and the adenine-cytosine dinucleotide. There is no systematic variation of i_d/C with *p*H for any of these compounds.

The half-wave potentials ($E_{1/2}$) are not constant but become more negative with increasing concentration. For adenine in perchlorate buffer of *p*H 1·30 at 25° C., $E_{1/2}$ varies from − 1·046 to − 1·073 volts ± 3 mV. *v.* the saturated calomel electrode over the concentration range $0·50 \times 10^{-4}$ *M* to $1·96 \times 10^{-4}$ *M*. Similar values are obtained for the other compounds.

The half-wave potentials vary in a linear fashion with hydrogen ion concentration, becoming increasingly negative as the *p*H increases. For adenine at a concentration of $0·50 \times 10^{-4}$ *M* in perchlorate buffers of *p*H varying from 1·30 to 2·24, at 25° C., the value of $E_{1/2}$ changes from − 1·046 to − 1·129 volts ± 3 mV. *v.* the saturated calomel electrode. The other compounds behave similarly.

Temperature coefficients of both $E_{1/2}$ and i_d have been determined, and the values of the respective coefficients are similar for all three compounds.

The logarithmic plots of the waves of the three substances are very similar, $\log i/(i_d - i)$ against $E_{d.e}$ being linear for the greater part of the wave. Calculations based on the slopes of these lines give fractional values for the number of electrons involved. For adenine $n = 1·33$. This, together with the fact that $E_{1/2}$ varies linearly with *p*H, suggests that hydrogen ions are also involved. For a reversible reaction involving two hydrogen ions and two electrons, the plot of $E_{d.e}$ against $\log (i_d - i)/i^2$ should be linear with a slope of 0·0295 at 25° C. All three substances give reasonably linear plots of $E_{d.e}$ against $\log (i_d - i)/i^2$ over the whole wave, and the values of the slopes of these lines range from 0·026 for adenine to 0·029 for adenylic acid, in fair agreement with the theoretical value for such a reaction. The observed variation of $E_{1/2}$ with concentration is also to be expected from these linear plots. It must be pointed out, however, that the value of i_d/C for adenine is more than twice as large as the corresponding value for a divalent metal ion such as zinc, so that a larger number of electrons may be involved. Various experimental considerations point to the possibility of the reduction occurring at the double-bond linking nitrogen at position (1) with carbon at position (6) in the purine ring. It is thought that this reduction process may have considerable biological significance.

The evidence obtained shows that in all three substances, and presumably also in the adenine-cytosine dinucleotide, it is the adenine moiety which enters into the electro-reduction, and that the other adenine-containing compounds are so constituted that neither the sugar nor the phosphoric acid groups can prevent the reduction.

In conclusion, it is pointed out that the polarographic reduction of adenine enables it to be estimated quantitatively in the presence of any one or all of the other purine or pyrimidine bodies mentioned here. For quantities of the order of 1 microgram the accuracy of estimation is about ± 2 per cent, but it is possible to detect much smaller quantities than this. The method is of direct and simple application to the estimation of adenine in the hydrolysates of either ribose or desoxyribose nucleic acids. Work on these lines is being continued, and further details will be published later.

These investigations are being undertaken for the British Empire Cancer Campaign (Birmingham Branch).

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Utilization of Groundnut-Cake Hydrolysate as Medium for Production of Streptomycin

SINCE the announcement of the discovery of streptomycin[1] rapid progress has been made in the treatment of infectious diseases which are resistant to penicillin[2–9]. The studies of Schatz *et al.*[1], on the influence of the composition of the media on the production of the active agent by *A. griseus*, revealed that the formation of streptomycin requires the presence of a certain organic substance supplied by meat extract or corn steep liquor. The formation of streptomycin was not affected by the nature of the peptone used, though the addition of glucose increased the yield of the antibiotic. Recently, Le Page and Elizabeth Campbell[10] have found that yeast extract media fortified with minerals gives the most satisfactory production of the antibiotic with *A. griseus*.

For some time past we have been interested in the utilization of enzyme hydrolysate of groundnut-cake as a medium for the production of antibiotics from members of the Penicillium and Aspergilli groups. The encouraging results obtained with these led us to the study of the formation of the antibiotic from *A. griseus*.

Enzyme digest of groundnut-cake prepared under specific conditions was distributed in 5 ml. aliquots into sterile tubes 15 cm. long and 1·7 cm. in diameter and autoclaved at 15 lb. pressure for half an hour. The tubes were then inoculated with a spore suspension of *A. griseus*

EFFECT OF MEDIA ON THE FORMATION OF THE ANTIBIOTIC ACTIVITY BY *A. griseus* (WAKSMAN'S STRAIN)
Incubation temperature, 28° C. (mean)

Number of days after inoculation	Mean halo-diameter of duplicates in millimetres	
	Enzyme digest media	Schatz–Waksman media
1	Nil	Nil
2	12	,,
3	10	,,
4	13	,,
5	16	10·5
6	17	13
7	10	14
8	Nil	14·5
9	,,	13
10	,,	13
11	,,	Nil
12	,,	,,

and placed in a slanting position at an angle of 20°–30° so as to offer a large surface for growth. A similar experiment was carried out with Schatz-Waksman media. Antibiotic activity was determined[11] using *B. subtilis* as the test organism, at the end of every twenty-four hours, by drawing out tubes from the incubator. The results are summarized in the accompanying table.

The results in the table clearly show that the groundnut-cake hydrolysate contains the factors necessary for the production of antibiotic by *A. griseus*. As a matter of fact, in the case of the groundnut-cake hydrolysate, the presence of the antibiotic is detectable within forty-eight hours of inoculation. The maximum antibiotic activity is reached between the fifth and sixth day. After the sixth day the activity decreases rapidly until the eighth day, when no activity can be detected. In the case of Schatz-Waksman media the picture is entirely different. It is only between the fourth and the fifth day that the presence of the antibiotic is indicated. Maximum activity is reached between the eighth and the ninth day. However, in this case the destruction of the antibiotic after reaching the peak activity is more gradual than in the case of groundnut-cake hydrolysate. Thus it is seen that groundnut-cake hydrolysate can be effectively used in the place of Schatz-Waksman media. We are also investigating the amino-acid and vitamin requirements of *A. griseus* for the production of antibiotic activity. The detailed results of our investigation will be published elsewhere.

Our thanks are due to Prof. V. Subrahmanyan, Drs. N. N. De and K. P. Menon for their interest in our work. We gratefully acknowledge the generous support from the Council of Scientific and Industrial Research, Delhi, under the auspices of which this work is being carried out.

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Presence of Fibrinogen in the Yolk Sac Content of Rabbits

INVESTIGATIONS of the prenatal mortality in wild rabbits[1,2,3] led us to examine embryologically many 8-, 9- and 10-day embryos. It was found that in a substantial proportion of these the yolk sac content could be seen macroscopically to be gelatinous and to contain an irregular network of fine fibrils. Microscopic examination revealed the presence of a fine reticulum in the yolk sac. This reticulum resembled histologically sections of a fibrin clot prepared from blood plasma that had been fixed and stained by the same technique. For this and other reasons it was suspected that the reticulum in the yolk sac was, in fact, fibrin.

An attempt was made therefore to determine experimentally if fibrinogen was normally present in the yolk sac content of 9-day embryos of tame rabbits. The fluid was aspirated by means of a hypodermic syringe from the uterine swellings while the animal was under ether anæsthesia, and was citrated. By this means it was possible to obtain approximately 0·5 ml. from each 9-day embryo. Care was taken to avoid contamination of the fluid with blood, and any samples in which this occurred were rejected. It was impracticable to ensure that the fluid content of the yolk sac so withdrawn was not contaminated with traces of embryonic fluid from the exocœl or with tissue exudate from the uterine lumen, but it is certain that the amount of such contamination, if any, was small. A solution of human thrombin was then added to the aspirated fluid and resulted in the rapid formation of a clot in all cases.

It must be concluded therefore that fibrinogen is normally present in substantial amounts in the yolk sac content of rabbit embryos. The concentration is too great to be accounted for by the possible contamination of the yolk sac fluid with traces of other embryonic or maternal fluids. Since the vascular system of the embryo is in an early stage of development at this time, it is probable that the fibrinogen in the yolk sac is of maternal origin. It was possible to estimate that the concentration of fibrinogen in the aspirated fluid was of the order of 50 per cent of that in blood plasma by comparison of the clots formed in parallel series of dilutions of the yolk sac fluid and of blood plasma and by microanalyses.

It is hoped to publish a full account of this work elsewhere, and further investigations are in progress. We would like to take this opportunity of expressing our thanks to Dr. R. A. Kekwick for advising us on the hæmatological technique and to the Medical Research Council's Serum Unit at the Lister Institute for kindly providing us with the human thrombin employed. We are indebted to the Agricultural Research Council for financing the work of which this is a part.

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An Antibiotically Active and Slightly Pathogenic Member of the *Bac. brevis* Group Found in Man

A TWENTY-YEAR old male Arab was admitted to the Government Hospital, Haifa, and died two hours after admission. Post-mortem examination performed about one hour after death revealed as cause of death complete occlusion of the jejunum by multiple intussusceptions, obviously brought about by masses of Ascarids present in the small intestines. But in addition to this condition, all lymphatic glands in the mesentery were found to be considerably enlarged and hard. The liver was slightly enlarged, the spleen showing no abnormality. Histologically, the mesenteric glands showed a marked disruption of their architecture; there was partial destruction of the lymphatic tissue with replacement by reticulo-endothelial hyperplasia, suggesting an inflammatory process of some duration. There were no signs of tuberculosis. Small necrotic foci were found in the liver.

In smears from the enlarged glands, no acid-fast organisms were found, but numerous capsulated Gram-negative bacilli were present. By culturing the glandular fluid on blood agar plates, rich pure cultures of these bacilli were obtained which, on further examination, proved to belong to the *Bac. brevis* group. They were non-pathogenic for rabbits and guinea pigs.

In the agar-plate test the strain inhibited the growth of *Staphylococcus aureus*, α- and β-hæmolytic streptococci, pneumococci and *P. pestis*. There was no inhibitory effect upon members of the typhoid-coli group and on the inhibiting strain itself.

Antibiotically active cell-free watery extracts could be prepared from cultures on Dorset's egg medium (which is liquefied by the bacillus) and from surface cultures on peptone-water. These extracts caused lysis, at pH 7·0–7·2, of all the organisms inhibited in the plate experiment and also of its own parent strain and of cultures of *Paramecium caudatum*.

The active principle is soluble in water, ethyl and *n*-butyl alcohol, but insoluble in ether, petrol ether and carbon tetrachloride.

The peculiar features of this strain are its origin, its pathogenic effect on the human lymphatic tissue, and the apparent difference of its active principle from tyrothricin.

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Resolution and Synthesis of Virus Complexes Causing Strawberry Yellow-edge

PRELIMINARY experiments on the resolution of strawberry virus complexes have shown that, after feeding for twenty-four hours on a plant infected with 'yellow-edge', the vector *Capitophorus fragariæ* Theob. transmits a single virus which is believed to be the 'mild crinkle' virus. This virus is transmitted after infection-feeding periods of 1 hour or more, persists for only a few hours in the vector and produces faint chlorotic spots on the leaves of Royal Sovereign strawberry[1].

Work by Wood and Whitehead at Bangor[2] has shown that two distinct viruses (one of which is more persistent than the other) can be isolated from plants infected with 'severe crinkle'. I have shown in more recent work that a persistent virus can also be isolated from plants infected with yellow-edge and that this virus is apparently distinct from the persistent virus of Wood and Whitehead. It has now been found that the combined action of the two viruses isolated from a plant infected with yellow-edge produces yellow-edge.

Aphids (*C. fragariæ*) fed for ten days on a Royal Sovereign plant infected with yellow-edge are transferred to uninfected plants of *Fragaria vesca*, and after feeding there for twenty-four hours are retransferred to a second series of uninfected *F. vesca* plants. The plants of the second series do not become infected with the 'mild crinkle' virus (since this virus does not persist in the vector), but a number of them develop symptoms of a mild type, namely, chlorotic spotting often accompanied by slight cupping of the leaves.

The virus producing these symptoms is retransmitted after infection-feeding periods of twenty-four hours or more, persists in the vector for several days and produces very mild and scarcely distinguishable symptoms of the yellow-edge type on Royal Sovereign strawberry. It is thus distinct from the mild crinkle virus already isolated, and will

be provisionally referred to as the 'mild yellow-edge' virus. When a Royal Sovereign plant infected with one of these viruses is grafted to one infected with the other, both plants develop severe yellow-edge symptoms.

It follows from these observations that yellow-edge is caused by the combined action of two distinct viruses (the mild crinkle virus and the mild yellow-edge virus), which can be separated by making use of differences in their vector relationships.

This conclusion does not, however, exclude the possibility that other viruses or combinations of viruses may also cause yellow-edge. Thus I have also found that a persistent virus (probably identical with the persistent virus of Wood and Whitehead) can be isolated from plants infected with 'severe crinkle'. This virus is transmitted by *C. fragariæ* after an infection-feeding period of ten days, persists in the vector for several days and, by itself, produces symptoms of the severe crinkle type on Royal Sovereign. The combination of this virus with the persistent virus isolated from a plant infected with yellow-edge, as described above, also produces severe yellow-edge.

Two etiologically distinct types of yellow-edge have therefore been synthesized, each produced by a pair of viruses, the pairs having the mild yellow-edge virus in common The second virus is, in one case, of the mild crinkle type and, in the other, of the severe crinkle type. The frequent occurrence of crinkle in association with yellow-edge has already been noted in grafting experiments[3], but the obligate nature of this association had not previously been demonstrated.

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Magnesium Chlorosis of Tomatoes

THE summary in *Nature*[1] of the paper by Walsh and Clarke[2] directs attention to the methods of treating tomato plants affected by induced magnesium deficiency. The paper emphasizes the importance in this connexion of the potash level in the soil, a relationship which was previously described by Cromwell and Hunter[3], and a review of the position may be timely.

Jones, Nicholas and Wallace[4], and Jones, Nicholas, Wallace and Jefferiss[5], stated that good control of magnesium deficiency in tomatoes was obtained by heavy applications of magnesium sulphate to the soil. Similar treatments given during several years in south-western Scotland have been ineffective.

In sand-culture experiments conducted in this College, absorption of magnesium decreased with increasing concentration of the solution in which the plants were growing; this effect of concentration was as important as was the ratio of ions in the solution: when the solution was relatively concentrated and also the ratio of potassium to magnesium in it was high, then the absorption of magnesium was most restricted and the chlorosis was most severe. The conductivity of soil surrounding chlorotic plants was always found to be high, and usually to be higher than that of neighbouring soil bearing healthy or less severely affected plants. A critically high concentration of soluble salts in the soil would thus probably be harmfully increased by applications of magnesium salts.

It has already been pointed out by Cromwell and Hunter[3] that this type of chlorosis may also be caused by factors other than the potash status of the soil.

In sand-culture and glasshouse work in this College, induced chlorosis in tomatoes was associated particularly with the use of potassium sulphate as a fertilizer, though excessive applications of other potassic fertilizers also induced the deficiency. The effect of potassium sulphate probably arises from the different rates of absorption of its ions. The chlorosis was not increased by raising the sulphate content of the tomato soils or sand-cultures above the normal level by means of sodium sulphate or calcium sulphate, the amounts of other fertilizers applied being adjusted to keep the concentration of soluble salts approximately constant.

That control of the chlorosis may be obtained by repeatedly spraying the foliage with magnesium sulphate solution has been reported by Jones, Nicholas, Wallace and Jefferiss[5], and control was obtained in this area when the plants were sprayed sufficiently often. It seems unlikely that spraying treatment will have practical value in the West of Scotland College area.

Several different types of soil cultivation for glasshouse tomatoes have been investigated at the College, but none was found effective in controlling the chlorosis.

Results obtained this season by, for example, early mulching with farmyard manure or peat suggest, however, that an encouragement of secondary root production may go far to offset the conditions under which induced magnesium deficiency appears.

This work has been done by co-operation between the Departments of Chemistry and Horticulture at the College.

Until new cultural methods have been fully investigated, the cure for induced magnesium deficiency, if it persists when the potash dressings are kept as low as possible, seems to lie in resoiling, and, taking into account the other advantages of resoiling, this may be economic.

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Aphosphorosis and Phosphate Reserves

THE solid rock substratum of County Offaly is almost exclusively Carboniferous limestone without igneous intrusions, overlain by extensive patches of bog land and glacial limestone drift. The aphosphorosis in Offaly cattle described by Prof. E. J. Sheehy[1] may be a permanent characteristic of certain areas; but during recent years the annual loss of tricalcium phosphate through the export of cattle from Eire has been of the order of 25,000 tons[2] in contrast to the 17,000[3,4] mentioned for New Zealand. This has not been restored to the soil. The normal imports, seriously reduced during the war period, are about four times as great. The drain on phosphorus from the soil is also being considerably aggravated by increased tillage, although the emergency production of phosphorite from West Clare[5] has offset this to a limited extent. There must therefore be certain areas where the rate of release of phosphorus from the rock via the soil into the vegetation can no longer keep pace with the demand, and where accordingly there will be created a deficiency in available phosphorus for years, unless it is artificially replaced. Significantly, this is reported from old pastures. The temporary restriction of phosphate imports would be of less account, but for the constant irreversible loss through the cattle export trade.

The phosphorus balance-sheets of those countries now exporting food will evidently require careful watching.

The somewhat unusual Carboniferous phosphorite deposits of West Clare, on which a preliminary note[5] was published in 1942, are to be described in greater detail elsewhere. They occur as thin flat lenses interbedded in black shales a few feet above the top of the Upper Carboniferous limestone, and are considered to have been deposited in shallow salt water not far from the land surface which provided the first outrush of Millstone Grit sediments into the crinoidal limestone sea. The shales were associated by Wheelton Hind[6] with equivalent beds in England and at Chokier in Belgium. The phosphorite lenses are by no means easy to locate, and while search in Ireland has been unsuccessful outside Co. Clare, it may still be worth while to conduct a careful examination of similar facies of this particular horizon in more distant areas.

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A New *Rh* Allelomorph

A CELL sample from a blood donor (*Abe* — —) was found to be of Group *O* Rh_2rh. That is to say, the blood was agglutinated by anti-*c*, anti-*E* and anti-*e*, but not by anti-*C* sera: the result with anti-*D* serum was variable. While the agglutination of this blood sample by certain anti-*D* sera was strong, using others it was weak, with only a few cells being clumped, and some gave completely negative results.

This suggested the presence of a new allele D^U at Fisher's *D-d* locus. The donor's cells would, therefore, be cD^UE/cde. This hypothesis is supported first by an examination of the donor's family, which showed the erythrocytes of the father and two brothers to be of the same type, and secondly by the discovery of two cell samples of the type CD^Ue/cde, and one of type CD^Ue/Cde[1].

Cells	Dilution of serum							
	Anti-*D* (i)							
	1	2	4	8	16	32	64	128
R_2r. (*Abe*— —)	+	+	+	+	+	+	—	—
R_2r. (*Ba*— —)	+	+	+	+	+	+	+	—
	Anti-*D* (ii)							
R_2r. (*Abe*—)	—	—	—	—	—	—	—	—
R_2r. (*Ba*—)	+	+	+	+	+	+	+	—

Thirty-two strong anti-*D* sera were tested against the donor's cells. Twelve tests were found to be positive, exhibiting agglutination of variable intensity. Twenty of the sera completely failed to agglutinate the cells, but some contained blocking antibodies to the donor's (*Abe*— —) cells. Typical results are shown in the accompanying table. Anti-*D* blocking antibody will apparently prevent the agglutination of the donor's cells by anti-D^U agglutinins.

All anti-D^U sera used so far are mixtures of anti-*D* and anti-D^U. Adsorption of anti-*D* + anti-D^U has not resulted in the production of a pure anti-D^U agglutinin. Attempted immunization of two persons both *Rh*-negative (the one having anti-*D* and anti-D^U and the other no agglutinins in the serum) with the donor's cells failed to produce an anti-D^U serum or to increase the titre of anti-D^U.

The above findings can only be properly assessed in terms of Fisher's hypothesis. It is especially helpful to consider closely the analogy with C^w[1,2]. In this case it was shown that previously known anti-*C* sera were of two classes, a pure anti-*C* and one consisting of mixtures of anti-*C* and anti-C^w. The ability of the antigen *C* to provoke either a pure anti-*C* serum or anti-*C* + anti-C^w showed a chemical similarity between the antigens and was perhaps in favour of C^w being an allele of *C*. Furthermore, the antigen C^w was shown to be inherited as part of a complex C^wDe. The reactions of individual heterozygotes such as C^wDe/cde could be interpreted in terms of C^w being an allele of *C*, but could equally be due to an antigen produced by a fourth closely linked locus (say, *F*). It could, however, be shown that as the new antigen was passed on from one generation to the

next it was not linked with C or c but replaced one of them. Finally, a homozygote C^wDe/C^wDe was found not to react with either pure anti-C or anti-c, and this very clearly showed that C,c and C^w were alleles.

The evidence so far available in the case of D^U shows a complete analogy with the facts known about C^w, and approaches definite proof that D^U is an allele of D and d. For a complete proof it will be necessary to have available an anti-d serum and either a pure anti-D^U serum or homozygous D^U/D^U cells.

When sera containing anti-D but not anti-D^U are used in routine typing, occasional cell samples will be put in the Rh' or Rh'' class which with the mixed type of serum would be classified as Rh_1 or Rh_2, with D^U in place of D. The results given for Rh' and Rh'' frequency by me[3] were determined using an anti-D plus anti-D^U serum. The frequency of D^U is unknown but seems likely to be low.

These donor's cells form an excellent medium for establishing the presence of blocking antibody in sera which also contain anti-D agglutinin. This assists in correlating findings in maternal sera with the severity of hæmolytic disease in affected children. In some severe cases of hæmolytic disease the maternal sera contained low-titre anti-D agglutinins. Re-examination of such sera with the donor's cells, while showing no agglutination, revealed strong blocking antibodies.

This allele D^U may also be similar to certain 'intermediate' genotypes described by Wiener[4].

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New Evidence for the Formation of Molecular Complexes in Monolayers by Penetration

THE formation of complexes of definite composition in monolayers as described by Schulman and Stenhagen[1], in particular with cetyl alcohol and sodium-cetyl sulphate, has been questioned by Harkins[2]. Harkins did not succeed in reproducing the discontinuities on the isotherms and has expressed doubt about the existence of the corresponding complexes and the validity of the experimental results in general. In fact, the shape of the isotherms is a function of time, on account of the instability of the monolayer (collapse or solubility); it is possible to notice changes of behaviour, of rate of collapse, of stability and of physical state, but without much precision about the molecular areas corresponding to the different regions. I have taken up again this question of the interaction in monolayers between cetyl alcohol and sodium alkyl sulphates using a slightly different technique which removes any doubt about the existence of the 1–1, 1–2 and 1–3 complexes.

The cetyl alcohol layer is spread on phosphate buffer $M/300$ at pH 8 and kept under constant pressure of 23 dynes/cm., by using triricinolein as piston oil. When the sodium-cetyl sulphate is injected, the area of the monolayer increases with time, passes through a maximum, then decreases to a constant value nearly double that occupied by the alcohol alone. The complex formed is of the type 1–1, and is solid and stable under 23 dynes.

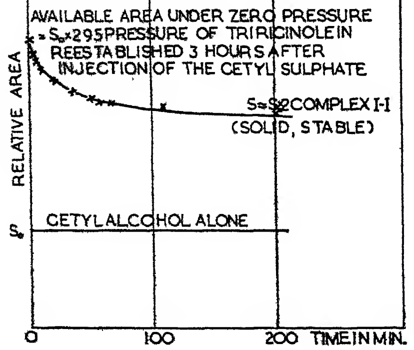

Fig. 1. VARIATION OF THE AREA OF MIXED FILMS OF CETYL ALCOHOL + SODIUM-CETYL SULPHATE WITH TIME. $T = 17°$, pH = 8 ($M/300$ PHOSPHATE)

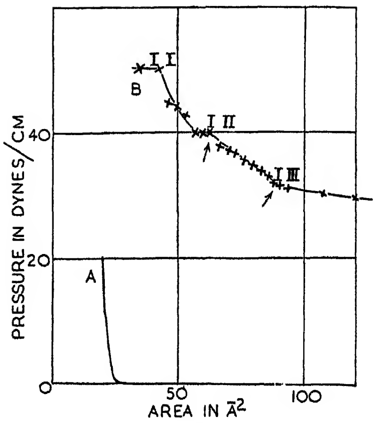

Fig. 2. *A*. COMPRESSION ISOTHERM OF CETYL ALCOHOL. *B*. CETYL ALCOHOL FILM PENETRATED BY SODIUM-CETYL SULPHATE. COMPRESSION ISOTHERM 3 HOURS AFTER EQUILIBRIUM PRESSURE AT LARGE AREA HAS BEEN REACHED. MEASUREMENTS TAKEN CONSECUTIVELY EVERY TWO MINUTES

Alternatively, if after forming the film of cetyl alcohol and measuring its area under the pressure of triricinolein, one expands it over a large surface before injecting the cetyl sulphate and re-establishes the pressure only after a few hours, the following facts are observed.

If the quantity of injected cetyl sulphate is relatively large (10 mgm. per litre), and if the available surface under negligible pressure is large (that is, six times the area occupied by the alcohol under the pressure of triricinolein) when the pressure is re-established, the area diminishes and settles at a value of four times the original area of the cetyl alcohol, the film being solid and stable below a pressure of 30 dynes: the complex is of the type 1–3 (Fig. 1).

It should be pointed out that if the available surface is not sufficient for the formation of the 1–3 complex, even with an excess of cetyl sulphate the area is reduced to the 1–1 complex, without the complex 1–2 being formed. This latter complex is not stable and is never formed spontaneously.

Information can nevertheless be obtained on the 1–2 complex in the following way: after forming the 1–3 complex, the pressure is increased by a given quantity and the variation of area is plotted against time. Definite changes of rate are shown at areas corresponding to the 1–2 and 1–1 complexes. The 1–2 complex is never obtained in a stable state, and even the 1–1 collapses in its turn if the pressure is high enough. Furthermore, if starting from the 1–3 complex which has been kept stable for 2–3 hours, an isotherm is established very rapidly, very abrupt changes of slope are noticed corresponding to the 1–2 and 1–1 complexes (Fig. 2). Identical results were obtained with sodium lauryl sulphate.

This method is of general use and has permitted us to study a very great number of pairs of substances giving complex monolayers in stoichiometrical proportions[3]. It should be emphasized that the formation of a complex can be established only if a range of pressure is found in which the mixed monolayer is relatively stable, that is, when the rate of collapse of the mixed monolayer is lower than that of the adsorbed layer of the soluble constituent alone under the same pressure. It is obvious that an adsorbed layer of the soluble constituent alone cannot withstand a pressure above its equilibrium pressure without dissolving. Thus the stability of the penetrated monolayer under a pressure above the proper pressure of the soluble constituent can be taken as a test for distinguishing a complex from an ordinary mixture. This evidently does not obviate the necessity of definite proportions between the constituents.

As a general rule, before injecting, the insoluble layer should be sufficiently expanded so that its pressure does not impede the adsorption and penetration of the soluble substance. In some cases, however, when the injected substance is very capillary-active, the insoluble layer must be maintained under sufficient pressure not to be displaced by the adsorption layer, and furthermore, the injection should be done very slowly. This is the case, for example, with lecithin and sodium lauryl sulphate complexes: working with caution, 1–4, 1–3 and 1–1 complexes are formed. Another indispensable precaution is to allow enough time to elapse (one or two hours) between the injection and the measurement: adsorption is sometimes very slow and the formation of the complex may also be very slow. For the area ascribed to the complexes, one should take the limiting value of the area as it decreases under constant pressure with increasing time. If sudden changes in the slope of this curve occur, areas corresponding to the transition points must be ascribed to the formation of successive complexes. This method enables one to find without any ambiguity, for the same pair of substances, complexes corresponding to a series of definite proportions. This can be illustrated by the following examples:

Lysolecithin + sodium palmitate: 1–1, 1–2, 1–3 solid complexes.
Lecithin + digitonin: 1–1, 1–3, 2–3 liquid complexes.
Heptadecylamine + digitonin: 2–1, 1–1, 2–3, 1–2 liquid complexes.

A simple explanation can be given for the unsuccessful trials encountered by the isotherm method. During the compression, mixed monolayers are, in most cases, in a metastable state. There is some sort of hysteresis in the reversibility of the formation of the complexes. On one hand, it is often found that a complex is apparently stable at a pressure higher than that under which it can form spontaneously. On the other hand, frequently a complex begins to be unstable at a

pressure lower than that which would be necessary to squeeze out the soluble constituent. The phenomena are more complicated when the two associated substances are liable to give several complexes, for example, 1–1 and 1–2. Suppose the 1–2 complex is formed; and then we try to obtain by compression the 1–1 complex. Very often, the squeezing out of one molecule of the soluble substance from the 1–2 complex requires a pressure at which the 1–1 complex is no longer stable; hence it is impossible with the isotherm method to determine the molecular area relative to the second complex, this remaining unobserved.

I should like to thank Dr. D. G. Dervichian for much stimulating criticism and advice.

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Electric Induction in Molecules and the Polarity of the C—H Bond

FOR non-mesomeric molecules the molecular electric moment may be formally divided into the vector sums of the group moments and of the induced moments. Calculation of these latter has been attempted by Smallwood and Herzfeld[1], Smyth[2] and Groves and Sugden[3]; but the number of examples of any one molecular type considered has been too small to substantiate the methods. The calculations of the last-named authors, based on a method suggested by Frank[4], appear to be the most valid.

The known or determinable geometry of ethylene oxide and its homologues, and the analogous sulphides and imines, makes these compounds particularly suitable for calculating electric induction within molecules. The dipole moments of the cyclic ethers are known with a fair degree of accuracy and are shown in the accompanying table. These values have been used in the preliminary calculations outlined below.

The original Groves–Sugden model is over-simplified in that methyl and methylene groups are treated as carbon atoms with the polarizability proper to the groups. This implies a polarization symmetry which the group does not possess, and accordingly the induced moment has now been computed separately for every atom in a molecule (Model 1). Equations are obtained relating the molecular moment, the group moments $\mu(CH_2 - O)$, $\mu(H - C)$ and the induced moment. Mutual solutions of these equations give simultaneous values of the group moments which average: $\mu(CH_2 - O) = 2{\cdot}05$ D., $\mu(H - C) = -0{\cdot}46$ D. Substitution of the latter value in the equations yields the individual values of $\mu(CH_2 - O)$ shown in the table.

Variation of polarizability with type of bond implies that the quantity depends chiefly on the bonding electrons. The Groves-Sugden model assumes that these electrons are symmetrically distributed over a spherical surface defined by the atomic covalent radius. The fact of directed valence indicates a localization of polarizable material. Accordingly a new model (Model II) has been used in which the bonding electron pair between two atoms is concentrated at the 'point of contact' of spheres with the appropriate covalent radii. Bond polarizabilities[5] are now employed, allowance being made in the case of the $CH_2 - O$ group for the unbonded electrons. Equations similar to those derived from Model I lead to average values of the group moments: $\mu(CH_2 - O) = 1{\cdot}83$ D., $\mu(H - C) = -0{\cdot}41$ D. Individual values of $\mu(CH_2 - O)$, obtained as before, are shown in the table.

In reality, there is neither a spherically symmetrical nor a point distribution of valency electrons. These are extremes, somewhere between which is the most probable configuration. For the ethylene oxide molecule, in which the two group moments are most closely juxtaposed, there is clearly under-compensation for the induced moment by Model I and over-compensation by Model II. For these two reasons the mean values of the group moments (see table) are taken to be approximately correct. The average of these gives $\mu(CH_2 - O) = 1{\cdot}93$ D., and correspondingly $\mu(H - C) = -0{\cdot}43$ D.

	Molecular moment μ	Group moment $\mu(CH_2 - O)$		
		Model I	Model II	Mean
		Debye units		
Ethylene oxide	1·88[5]	1·58	2·02	1·80
Trimethylene oxide	2·01[6]	2·15	1·72	1·94
Tetramethylene oxide	1·71[7]	2·20	1·74	1·97
Dimethyl ether	1·28[8]	2·20	1·80	2·00

The magnitude of the moment of the C — H bond was determined by Timm and Mecke[9] as ~ 0·3 D. and by Rollefson and Havens[10] as 0·31 D. from measurements of refractive indices in the infra-red region. It has been calculated by Coulson[11] to be 0·4 D. The result of the present investigation is, therefore, in fair agreement.

The sign of the moment has caused some controversy. Smyth[1] supports the view that the polarity is $\bar{C} - \overset{+}{H}$, chiefly on the grounds that the parallelism of electronegativity difference and bond moment demands such a relation. A calculation by Hirschfelder reported by Smyth appeared to substantiate the position, but Coulson[11] has shown that the treatment is incorrect and that, in fact, application of the method of molecular orbitals to methane leads to the polarity $\overset{+}{C} - \bar{H}$. The calculations reported here also indicate this charge distribution.

An attempt is being made to formulate a more adequate model than either of those used, and the measurement of the dipole moments of the cyclic oxides, sulphides and imines in the vapour phase is in progress. Details of the calculations outlined above will be published elsewhere in due course.

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The Three Coefficients of Viscosity of Anisotropic Liquids

BEFORE and during the War, investigations were reported on the viscosity of anisotropic liquids[1,2,3,4]. As is well known, the flow of an anisotropic liquid influences the orientation of the molecules. On the other hand, the value of the viscosity coefficient depends on this orientation. Therefore this coefficient is a function of the velocity-gradient, and the usual definition of the viscosity coefficient for these liquids loses its significance. If under the influence of any factor the molecules of the liquid should be orientated in one direction and the motion is unable to change this orientation, then we have the viscosity coefficient in the ordinary sense. But in this case we have to deal with the anisotropy of the viscosity, and in case of a liquid of the type of *p*-azoxyanisol we have three principal viscosity coefficients belonging to the three directions of orientation; these are: (1) direction of the flow; (2) direction of the velocity gradient; (3) perpendicular to both these directions. Having given the molecules an orientation by means of a magnetic field in such circumstances that the flow did not change this orientation, I obtained the following values for the three principal viscosity coefficients for *p*-azoxyanisol and *p*-azoxyphenetol[5].

Substance and temperature	Molecules parallel to the direction of the flow, η_1	Molecules parallel to the gradient of velocity, η_2	Molecules perpendicular to the direction of flow and to the velocity gradient, η_3
p-Azoxyanisol 122° C.	0·024 ± 0·0005	0·092 ± 0·004	0·034 ± 0·003
p-Azoxyphenetol 144·4° C.	0·013 ± 0·0005	0·083 ± 0·004	0·025 ± 0·003

These results throw light on those obtained by the other investigators. The results of the older investigators (Eichwald[5] and Dickenschied[6]) obtained by the method of flow through capillary tubes are in agreement with my results. Evidently, in both cases we were dealing with the orientation of molecules parallel to the direction of flow. Zwetkoff and Michajlow[3], using the method of flow through a tube with rectangular cross-section, by application of the strongest available magnetic field and with the smallest possible velocity of flow, obtained values about 80 per cent of my value, η_2. From the dependence of the results on the intensity of the magnetic field, it is clear that these investigators did not reach the state of constant orientation of molecules, and that the flow of the liquid changed this orientation. The results obtained by these authors for the different values of velocity and for different intensities of magnetic field lie between η_1 (orientation parallel to the flow) and η_2 (parallel to the velocity gradient) $\eta_1 \leq \eta_{Zwetkoff} < \eta_2$.

The measurements recently published by Becherer and Kast[4] were not carried out with constant orientation of the molecules. They were, however, orientated (at least in the layers where the phenomenon of viscosity chiefly takes place) in the planes of friction, but without a definite angle in this plane. The value obtained by these investigators is therefore not one of the three principal coefficients in the sense given by me. Clearly, $\eta_1 < \eta_{Kast} < \eta_3$, because in my measurements of η_1 and η_3 we have also an orientation parallel to the plane of friction, but once parallel and then perpendicular to the direction of the flow.

Hence the coefficient η_1 was measured by other workers as well as by me. The method of flow through capillaries gives usually the result corresponding to an orientation of molecules in the direction of flow; the other values given by different investigators do not correspond to constant orientation of molecules.

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Photovoltaic Effects Exhibited in High-resistance Semi-conducting Films

MICROCRYSTALLINE layers of lead sulphide have been obtained which, after suitable activation, exhibit photovoltaic effects of a new type.

The photosensitive layer consists of a film about 1 micron in thickness deposited on glass between graphite electrodes a few millimetres apart. When illuminated by infra-red radiation of wave-length between approximately 1 and 3·5 microns, a photo E.M.F. is developed between the electrodes. It has been shown that this effect is independent of the contacts between the semi-conductor and the electrodes, and is due to the internal properties of the sensitive material. Cells with resistance of a few megohms and photo E.M.F. reaching 2 volts have been produced. These cells, as might be expected, show pronounced rectifying properties, the ratio of conductivities for opposite directions of current being about 100 : 1 at room temperature. The photo current is always in the direction of high resistance.

The cells were produced as a result of information obtained during development work on the photoconductivity of activated thallium sulphide and lead sulphide layers. It is generally accepted that conductivity in semi-conductors is associated with the presence of impurity centres in the crystalline lattice. The impurity centres may be either electro-positive or electro-negative, giving rise respectively to 'electronic' or 'hole' components of conductivity. Consideration of our results obtained from sensitizing treatments in oxygen and *in vacuo* leads to the conclusion that impurity centres of either sign may be introduced, and further support is given to this by measurements of the Hall coefficient. High conductivity due to the presence of impurity of one sign alone is not associated with photosensitivity. The best photoconductivity in a given layer appears when maximum resistance is obtained, which may be explained by the existence of some kind of equilibrium between impurity centres of both signs which are simultaneously present. Also the experimental results are best explained by the assumption that the positive and negative centres are not uniformly distributed and that variations in relative concentration are closely associated with the microcrystalline structure of the layer, some of the crystals having a concentration of centres of a given sign different from their neighbours.

A semi-quantitative model was developed which postulated the existence of barriers at the boundaries of the crystals, with unequal concentration of impurity centres on opposite sides. The properties of normal photoconducting layers could be explained by random orientation and distribution of these barriers, but the possibility also arose of orientating them to produce a resultant photovoltaic effect from the cell. Such a cell, because of the superposition of the effects of many individual elements in series, should be strongly rectifying and, unlike the usual photovoltaic cells, should have a high resistance and high voltage sensitivity.

The treatment which was successful in producing photovoltaic cells of this kind consisted in passing a current through the photoconducting film at a temperature sufficiently high to ensure mobility of oxygen ions (about 250° C.). The direction of the resultant photo E.M.F. is in the opposite sense to the activating current. Layers treated in this way also show a marked directional photoconductivity; the conductivity in the high-resistance direction is strongly increased by illumination, and in the low-resistance direction the increase is less pronounced.

Under certain conditions, non-uniform activation across the cell may be obtained; and it is found that the photovoltaic and photoconductive sensitivity are always associated with the same part of the layer, as would be expected from the above considerations. Also in exceptional cases the sensitive area can be displaced across the layer towards the positive electrode, indicating the mobility of negative centres and a fairly uniform distribution of positive centres.

A full description of the experimental work and a more detailed development of the theoretical considerations will be given elsewhere.

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Surface Area Determination

IN the determination of surface area using nitrogen at the temperature of liquid nitrogen by the method of Brunauer, Emmett and Teller[1], it is usual to determine the dead-space on each sample, using helium. For routine determinations on a substance known to give *S*-shaped isotherms, that is, where the equation of Brunauer, Emmett and Teller is applicable, it is possible to avoid this dead-space determination. If V_1 c.c. nitrogen are adsorbed at a pressure p_1, then the dead-space is given by

$$p_1(1 + \alpha)D \simeq p_1 D,$$

where D is dead-space at unit pressure and α is a correction factor equal to $6{\cdot}58 \times 10^{-5}$ at unit pressure. Hence, if V_{c1} is volume of nitrogen in the sample bulb, then

$$V_1 = V_{c1} - p_1 D; \quad V_2 = V_{c2} - p_2 D; \quad V_3 = V_{c3} - p_3 D.$$

It follows that,

$$V_1 = V_{c1} - p_1\left(\frac{V_{c3} - V_3}{p_3}\right).$$

Emmett[2] points out that a line drawn through the origin and one adsorption point at a relative pressure of *c*. 0·3 usually differs in slope by less than 5 per cent from that drawn using several adsorption points.

If this is assumed, then

$$V_1(p_0 - p_1) = V_2(p_0 - p_2) = V_3(p_0 - p_3).$$

Therefore

$$V_1 = V_{c1} - \frac{p_1}{p_3}\left(V_{c3} - V_1 \cdot \frac{p_0 - p_1}{p_0 - p_3}\right).$$

Rearranging,

$$V_1 = \frac{V_{c1} - V_{c3}\dfrac{p_1}{p_3}}{1 - \dfrac{p_1}{p_3}\left(\dfrac{p_0 - p_1}{p_0 - p_3}\right)};$$

and similarly for V_2.

In the plot of p/p_0 against $\frac{p}{V(p_0 - p)}$, the monolayer volume V_m is the reciprocal of the slope, that is,

$$V_m = \frac{(p_2 - p_1)/p_0}{p_2/\{V_2(p_0 - p_2)\} - p_1/\{V_1(p_0 - p_1)\}}. \quad (1)$$

This involves determining three adsorption points, but no dead-space: a slightly less accurate value can be found using only two points, that is,

$$V_m = \frac{p_1/p_0}{p_1/\{V_1(p_0 - p_1)\}} = \frac{V_1}{p_0}(p_0 - p_1).$$

In neither case is it necessary actually to plot the points.

Areas determined on various substances by the usual technique, that is, involving a dead-space determination, are compared with those obtained by recalculation using equation (1) above in the following table:

Substance	Area in sq. m./gm.	
	By dead-space determination	By recalculation
Carbon *A*	790	753
Carbon *B*	847	840
Carbon *C*	814	800
Carbon *D*	460	460
Carbon *E*	280	282
Chalk *A*	30	29
Chalk *B*	19	19
Paris White	2	2
Clay	10	10
Asbestos	18	14

It will be noted that the calculated areas are generally lower than the dead-space areas, that is, the slopes are too great: this is in accordance with the assumption made above.

Our thanks are due to the directors of the Washington Chemical Company, Ltd., for permission to publish this note.

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An Optical–Acoustic Method of Gas Analysis

Bell, Tyndall and Röntgen all knew that gases and vapours absorb infra-red rays and that they would produce sounds if a stream of rays was interrupted at sonic frequencies. The mechanism of this phenomenon is as follows. When a gas absorbs infra-red rays, it is heated and its pressure increases. If the stream of radiation is interrupted at sonic frequency, there are rapid changes of pressure in the gas. Pulsation takes place, which is nothing more nor less than sound. The pitch of the sound depends on the frequency at which the rays are interrupted, and its strength on the ability of the gas to absorb infra-red rays. If pure air, in which there are no extraneous gases or vapours, is submitted to interrupted irradiation with infra-red rays, there will be no sound, since oxygen and nitrogen, of which the air is composed, do not absorb infra-red rays. If the rays are passed through a mixture of air and a gas or vapour, the sound produced will be louder the greater the quantity of extraneous matter present in the air.

Tyndall first spoke of using this phenomenon to detect gases in mines so early as 1888. He had at his disposal no instrument with which to measure the strength of sounds, and could not therefore put his idea into practice. The idea of using interrupted infra-red rays for this purpose was forgotten until 1937, when I developed my optical-acoustic gas analyser, involving the use of modern reception and measuring instruments. This analyser will determine the quantitative composition of a gas mixture the qualitative content of which is already known. The method is almost universal and will detect all gases except oxygen, hydrogen and nitrogen, which do not absorb infra-red rays.

The principle of the analyser is, briefly, as follows: Infra-red rays are emitted by an electrically heated platinum ribbon in a closed box with a window through which rays pass. They are inter-

rupted two hundred times a second by a revolving disk with an aperture in it. These rays are directed into the gas chamber containing the mixture to be tested. The chamber has a window at one end to admit rays and a microphone at the other. When infra-red rays enter the gas mixture, its pressure is increased by heat generated by absorption and the microphone membrane is depressed. When the flow of infra-red rays is interrupted, the gas expands and the microphone membrane returns to normal. Pulsations of the microphone are amplified, the current is rectified and measured on a needle galvanometer. Deflexions of the galvanometer needle therefore correspond to the quantity of gas in the air of the experimental chamber. The connexion between the galvanometer readings and quantity of gas in the chamber can be determined experimentally by using known concentrations.

The optical-acoustic gas analyser can also sometimes be used to determine the presence of several different gases in the atmosphere, and also to measure the contents of mixtures of gases which do not contain air. The instrument is practically instantaneous in action and so sensitive that it will determine the presence of ether in a concentration of 0·1 milligram in a litre of air.

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Moscow. May 16.
(By cable.)

Production of a Derivative of 5 : 6 Anhydroglucose by the Hydrolysis of an Ethereal Sulphate

ALTHOUGH it is now well established[1,2,3] that the alkaline hydrolysis of suitably substituted hexoses carrying sulphate groups on either the 3 or 6 positions readily yields 3 : 6 anhydrohexose derivatives, all our attempts to obtain evidence for the formation of ethylene oxide rings have been, until recently, unsuccessful, in marked contrast to the behaviour of the toluene-*p*-sulphonates[4]. It is now evident that this has been due largely to the fact that the barium salts of the sugar ethereal sulphates investigated were insoluble in organic solvents and the hydrolyses had, in consequence, to be carried out in aqueous media. Under such conditions experimental difficulties arise, for any ethylene oxide derivatives which may have been formed would be hydrolysed with accompanying Walden inversions[4]. Thus since the ethylene oxide ring formation would also involve a Walden inversion on the carbon atom where the sulphate group was originally attached, the production in recognizable quantity of a derivative of a hexose different from that in the original starting material depends on the relative ease of fission of the two ethylene oxide ring linkages. Thus the hydrolysis of a derivative of glucofuranose-3-sulphate could yield a 2 : 3 anhydro-allofuranose, which might give either a gluco- or an altrofuranose derivative, or both[3].

This difficulty has now been overcome by the choice of barium 1 : 2-monoacetone-3-methyl-glucofuranose-6-sulphate as starting material. Treatment in methanolic solution with sodium methoxide at 40° for 3 hours yields 1 : 2-monoacetone-3-methyl-5 : 6 anhydro-glucofuranose, the structure of which is proved by further treatment with sodium methoxide at 90° and hydrolysis to give crystalline 3 : 6-dimethylglucose $[\alpha]_D^{15^\circ}$ + 61° (equilibrium in water), m.p. 116°, not depressed by an authentic specimen kindly provided by Dr. D. J. Bell[5]

It is clear, therefore, that when conditions are suitable and the formation of a 3 : 6-anhydro ring is prevented by substitution, the hydrolysis of an ethereal sulphate readily gives rise to the production of an ethylene oxide ring, as in the case of the toluene-*p*-sulphonates. It is to be expected, therefore, that when the sulphate substituent is located on an asymmetric carbon atom with an adjacent hydroxyl group in the *trans* position, an ethylene oxide ring with accompanying Walden inversion will be produced on hydrolysis. Experiments are now in progress to test this hypothesis, which, if substantiated, will make it necessary to envisage the possibility of the interconversion of sugars in Nature through the intermediate formation of ethereal sulphates.

E. G. V. PERCIVAL
R. B. DUFF

Department of Chemistry,
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May 28.

[1] Percival and Soutar, *J. Chem Soc.*, 1475 (1940).
[2] Duff and Percival, *J. Chem. Soc.*, 830 (1941).
[3] Percival, *J. Chem. Soc.*, 119 (1945).
[4] Peat, *Ann. Rep. Chem. Soc.*, 260 (1939).
[5] Bell, *J. Chem. Soc.*, 1553 (1936).

Experimental Data and 'Sufficient' Accuracy

DURING a recent investigation on electron gun systems which involved the collection of numerical data—the measurements of a certain distance—the problem arose as to how many data it was necessary to collect in order to achieve sufficient accuracy in the final result, which, in this case, was ± 2 per cent. Use was made of the formula:

$$\alpha = 0{\cdot}6745 \sqrt{\frac{\Sigma (x_n - M)^2}{n(n - 1)}},$$

where α is the most probable error of the arithmetic mean M, of a series of n observations x_1, x_2, etc.

A series of ten observations was made of the distance in question, on one system: the arithmetic mean of the observations 1 to n was calculated for each value of n, and hence α was determined for each of these sets. From the table of results it will be seen that α decreases with ascending values of n until the minimum value permitted by the experimental conditions is reached. Although it appeared that seven observations were sufficient to give the desired accuracy, it was decided to use ten in case greater experimental difficulty was encountered on other systems. This was justified when the values of $\alpha\sqrt{n}$, a measure

n	x_n	M	α
1	23·9	23·9	—
2	20·9	22·4	1·0
3	20·0	21·6	0·8
4	22·4	21·8	0·6
5	22·7	21·9	0·5
6	24·4	22·4	0·5
7	21·7	22·3	0·4
8	25·6	22·7	0 4
9	21·7	22·6	0·4
10	20·6	22·4	0·4

of the 'fineness' of the observations, were found to vary slightly on the next ten systems, although, in every case, the most probable error of M was approximately the same as that required.

H. A. HUGHES

Standard Telephones and Cables, Ltd.,
Footscray, Kent.
May 8.

Gesture as a Constant Factor in Linguistics

IN May 1936, I wrote an article on KU in Chinese, which, through the courtesy of Prof. P. C. Chang, a Chinese philosopher then in London, was passed on to Prof. Y. R. Chao, the philologist, then in Nanking. The words and their meanings were taken from Karlgren's "Analytic Dictionary of Chinese and Sino-Japanese" (1923).

Of thirty-five words in KU- (or its variants, χU, KŬ, etc.), all except one were found to bear meanings which were simply connected with one or other of the natural gestural meanings of the mouth gesture.

I have heard from Prof. Alexander Johannesson that Prof. Chao (now in the United States) has written to him, referring to this article, and suggesting that the gesture theory may be "a constant factor for linguistic phenomena and not merely a theory to explain the history of words".

With this suggestion I would personally agree—in view of the comparative frequency of appropriate mouth gesture in children's invented words, in new words (such as 'blimp') or in new meanings for old words (such as 'slump').

R. A. S. PAGET

11 Cottesmore Gardens,
Kensington, W.8.
June 10.

Growth Curves

IN NATURE of January 19, 1946, there is a short communication by Prof. W. G. Burgers on "'Stimulation Crystals' and Twin-formation in Recrystallized Aluminium". As indicated in ref. 1 to this communication, the analysis of the forms of the grain boundaries was carried out by J. Sandee and appears in the Dutch journal *Physica* in 1942.

I should like to direct attention to the remarkable similarity between the curves analysed by Sandee and those discussed in a paper by me in the *Edinburgh Mathematical Notes* of December 1945 entitled 'Curves Formed by Colonies of Micro-organisms Growing on a Plane Surface". My paper is a more detailed mathematical analysis arising out of work which I undertook at the University of Glasgow in connexion with a communication by Drs. G. Pontecorvo and A. R. Gemmell, entitled "Colonies of *Penicillium notatum* and other Moulds as Models for the Study of Population Genetics" and published in *Nature* of October 28, 1944.

The curves analysed in these two separate fields, of physical chemistry and the growth of living organisms, are identical. This rather remarkable fact may be of mutual help to workers in both fields, while at the same time it offers scope for some interesting philosophical deductions.

AGNES H. WADDELL

c/o J. Rössler,
Bredovska 15, Prague II.
May 16.

Postal Communication with the U.S.S.R.

IN September 1945 I had the privilege, as president of the Genetical Society, of inviting four distinguished Russian geneticists to a conference in London, to take place on October 31. I received a reply from one of them in February of this year, and on May 30 a reply from another which runs as follows:

Moscow, May 3, 1946.

Dear Dr. Darlington,

I am very grateful to you for your invitation to the Conference of the Genetical Society dated September 19th, 1945. Unfortunately, it reached me on the 27th of [April] 1946, so that I couldn't possibly avail myself of the opportunity. I do not lose hope of meeting you in the near future at the next session of your Society.

Very sincerely yours,
(Sgn.) N. P. Dubinin.

The letter bore the air mail post-mark of May 19, my letter having evidently been received on April 27 and replied to six days later. I have received no reply from the other two invited guests.

Since I find communication with my Russian colleagues so difficult, especially with my old friends Lewitzky and Karpechenko, may I be permitted to make use of these columns to say how much I, and my colleagues in Great Britain, look forward to the renewal of our scientific intercourse?

C. D. DARLINGTON

John Innes Horticultural Institution,
London, S.W.19.

RESEARCH ITEMS

Breeding of the Rock-Dove

FOLLOWING his finding of rock-doves (*Columba l. livia*) in full nesting activity in January 1944, at Eathie Shore by Cromarty, John Lees has made further observations in the same caves, which show that breeding activity goes on more or less all the year round (*British Birds*, 34, No. 5, May 1946). There is a marked maximum in April, coinciding with the general nesting season for resident birds. The minimum occurs in July, and this may be coincident with the moulting of the body feathers; moulting certainly proceeds during the autumn months. Periods of nesting alternate with periods of quiescence, the latter being usually quite short and sometimes non-existent through the interlapping of active periods. The active periods fall into four groups. There is the main period of spring nesting, where hatching takes place about April. This is followed, after a break, by a summer activity, young birds appearing in August. After this come autumn and winter periods, with hatchings about November and January.

Classification of Dermestid Beetles

MISCELLANEOUS PUBLICATION No. 511 of the United States Department of Agriculture is of general interest to entomologists. It deals with the classification, based upon larval characters, of beetles of the family Dermestidæ, and is written by Bryant E. Rees, of the Division of Insect Identification, U.S. Bureau of Entomology and Plant Quarantine. Included in this family are the larder, hide and carpet beetles, all of which are highly injurious to the activities and interests of man. In their larval stages these insects feed upon, damage or destroy a wide range of goods, especially those made of, or containing, leather, hair, fur, wool or silk, besides museum specimens and numerous stored products such as bacon, cheese, seeds, grain, cork, etc. In war-time, many kinds of military stores have to be protected against their attacks. The adult beetles, however, are not directly injurious to any great extent. In order to control the damage caused by Dermestidæ, a knowledge of their larvæ is, therefore, of prime importance. While numerous scattered and usually inadequate descriptions exist, no general work on the subject had been undertaken. The present pamphlet will, it is believed, prove a useful aid to the identification of the various genera, and economic entomologists especially will welcome its appearance. It is interesting to note that a study of the larvæ of species of *Entomotrogus*, *Eucnocerus* and of several species of *Trigoderma* revealed no characters by which the three genera could be separated; they agree in all constant characters, and it is suggested the species may all be congeneric.

Bacteriostatic Substances in Fungi

W. H. Wilkins and G. C. M. Harris are continuing their examination of various fungi for the production of bacteriostatic substances (*Trans. Brit. Mycol. Soc.*, 27, 113; 1945). This third group of a hundred species and strains of *Aspergillus* shows quite a good measure of bacteriostatic activity against three representative types of bacteria—*Staphylococcus aureus*, *Bacterium coli* and *Pseudomonas pyocyanea*. It becomes increasingly clear, however, that every isolation should be treated as "an individual fungus whose physiological potentialities are probably quite distinct from other isolations and strains of the same fungus". The production of bacteriostatic substances varies with different media. Malt, potato dextrose and modified Czapek-Dox agar have been found most generally suitable, but it seems possible that optimal media could be made to suit particular fungi.

Genetics of Blight-Resistant Potatoes

SEVERAL potato seedlings resistant to blight, *Phytophthora infestans*, have been produced by the Scottish Plant Breeding Station, Corstorphine, Edinburgh. William Black has recently analysed the genetics of these productions (*Proc. Roy. Soc. Edin.*, B, 62, Pt. 2, No. 20; 1945), which apparently owe their resistance to the 'wild' ancestor, *Solanum demissum*. Derivatives of the triple hybrid (*S. Rybinii* × *S. demissum*) × *S. tuberosum*, and of a multiple species hybrid involving *S. commersonii*, *S. maglia*, *S. edinense*, *S. demissum* and *S. tuberosum* have been tested for their reaction to strains 'A' and 'B' of the blight fungus. The evidence indicates that resistance to blight is controlled by major genes, though minor genes determine the degree of susceptibility in susceptible varieties. Consistent excesses of recessive individuals over the expected standard ratios were found in the segregation of resistant and susceptible plants. This may be due in part to chromosome homologies leading to multivalent-formation and double reduction. In the material studied, however, the deviation in favour of recessives diminishes in consecutive generations. This is interpreted as a lowering of residual incompatibility factors derived from the original 'wild' material, and should augur well for the practical usefulness of subsequent generations.

Marsh Spot Disease of Peas

SOME disorders of plants require the joint ministrations of pathologist and chemist for diagnosis and control. Marsh spot of peas, where dark-brown lesions appear on the flat sides of the cotyledons, is not caused by any parasite; it is a symptom of manganese deficiency. Thomas Walsh and Stephen J. Cullinan (*Proc. Roy. Irish Acad.*, 50, B, No. 15, 279, June 1945) have shown that the varieties Laxton's Superb and Blues were unaffected, Marrowfat and Alderman had moderate attacks, while Onward and Giant Stride showed severe lesions. Application of 56 lb. of manganese sulphate an acre reduced the malady somewhat, but spraying the foliage with 1 per cent manganese sulphate solution at flowering time resulted in complete control.

Rust of Cultivated Roses

OF nine rusts recorded on species of *Rosa* in the United States only *Phragmidium mucronatum* is of economic importance, and this is virtually restricted to the western seaboard. A detailed study by V. W. Cochrane (*Cornell Univ. Agric. Exp. Sta.*, Mem. 268; 1945) shows that the uredospores are relatively short-lived and are killed by extremes of temperature. In California the mild climate enables uredospores to persist all the year and to maintain a high level of infection, whereas in the eastern United States, spring infection is entirely from teleutopores, and uredospore formation is checked by the heat of summer. Host-parasite relations and conditions of spore germination and development are fully tabulated.

Currents of the Bosporus

IN a paper on the hydrography of the Bosporus published in the *Geographical Review* of January 1946,

P. Ullyott and O. Ilgaz bring forward new facts on bathymetry and current flow confuting the old idea of a simple surface flow southward from the Black Sea and a bottom flow northward to the Black Sea. New facts regarding submarine relief show a threshold at the Black Sea end of the Bosporus against which ends the deep canal of the strait. This fact, and that of the low salinity of the deep waters of the Black Sea, will not conform to the usually accepted theory. The authors agree that currents in the Sea of Marmora and Bosporus are as generally accepted, but that the northward flow in the deep canal, on account of the shallow threshold, never reaches the Black Sea, but is turned back and incorporated in the southward setting surface current. Thus the Black Sea does not receive any water through the straits, and a balance is effected by gain through drainage supply, loss by evaporation and outflow by surface current into the Ægean Sea. This balance sheet of gain and loss, if true, would account for the low salinity of the deeper waters of the Black Sea.

Porosity of Rocks and Geospheres

G. A. Maximovich (*Bull. Acad. Sci. URSS, Sér. géograph. géophys.*, 8, 298; 1944), after making a compilation of several thousands of determination of rock-porosity, including numerous unpublished data from Russian sources, has calculated the average porosities of different types of rocks and has also calculated the average porosities of the geospheres. These, in percentages, are as follows: pedosphere (soils), 55; pelosphere (oozes, etc.), 50; hypopedosphere (subsoils, etc.), 40; stratisphere (sedimentary rocks), 25; metamorphosphere (metamorphic rocks), $2\frac{1}{2}$; granitosphere (acid igneous rocks), 1; basaltosphere (basic igneous rocks), less than 1. These calculations allowed him to calculate the average degree of compaction for various rocks and to draw some conclusions which may be of interest to oil- and water-geologists, geophysicists and geochemists.

Surface Tension of Mercury

The surface tension of mercury has been the subject of many investigations under very different conditions and by many different methods; but measurements are in nearly all cases confined to temperatures above 0° C. Bircumshaw, in 1931, was, according to his own statement, the first to measure the surface tension within the region 0° C. and the freezing point $-38 \cdot 6°$ C. He used the maximum bubble pressure method and found that at the lower temperatures the relationship between the surface tension and the temperature was not linear and that there was some evidence that mercury has a positive temperature coefficient of surface tension just above the freezing point. Since Bircumshaw's work it would appear that the only determination of the surface tension below 0° C. is that of S. Mussa and B. Takla at the Fouad I University in Cairo. A report of their work has just recently reached Britain (*Bull. Fac. Sci.*, No. 24, 1; 1941). They determined the surface tension at approximately 5° C. intervals over the range 67° C. to $-20°$ C. using the large-drop method as modified by A. E. Bate. The surface tension increases linearly from 67° C. to $-5°$ C., but as the temperature is still further reduced the surface tension decreases considerably and there is a marked deviation from a linear relation. The shape of the curve resembles somewhat that obtained by Bircumshaw. No explanation is given for the fall in the surface tension; but it is asserted that it can scarcely be due to experimental error or to impurity in the surface of the mercury. The mercury used was purified and doubly distilled and the surface tension measured *in vacuo*.

Phosphorylation

Esters and amides of phosphoric acid play an important part in many biological processes, but their laboratory synthesis is still a matter of difficulty. In work on purine glycosides, a convenient method for the phosphorylation of alcohols, in particular carbohydrates, and amines is necessary. F. R. Atherton, H. T. Openshaw and A. R. Todd (*J. Chem. Soc.*, 382; 1945) give a review of known phosphorylation procedures and describe experiments on the use of dibenzyl chlorophosphonate, $(CH_2Ph.O)_2POCl$, as a reagent. It cannot be distilled but can be used in carbon tetrachloride solution. It readily reacts with amines to form dibenzyl aminophosphonates, and with alcohols in presence of pyridine and with sodium salts of phenols, to give dibenzyl phosphoric esters. The benzyl groups in these products can be removed by hydrogenolysis. H. McCombie, B. C. Saunders and G. J. Stacey (*J. Chem. Soc.*, 380; 1945) also describe the preparation of some esters containing phosphorus. Dialkyl chlorophosphonates (dialkylphosphoryl chlorides) are formed by the reaction of a dialkyl hydrogen phosphite with chlorine in the cold; the dialkyl chlorophosphonate, obtained in high yield, is readily identified by the formation of crystalline aminophosphonates with amines. Other methods of preparation are described.

General Magnetic Field of the Sun

T. G. Cowling (*Mon. Not. Roy. Astro. Soc.*, **105**, 3; 1945) has reviewed some previous theories to explain the sun's electric field, and he points out that all are inadequate. A first investigation by the author shows that the time of decay of the sun's magnetic field, assuming that it decays only as a result of electromagnetic effects, is about 5×10^9 years, and as this seems a long time, the matter is investigated in more detail. As a result of this investigation, Cowling finds that the period is about 10^{10} years, which is of the order of the time-scale of the expanding universe, and the magnetic field may be a relic from a different primeval state. The assumption that the sun's magnetic field is explained by some unassigned cause operative so long ago is a confession of ignorance, for which reason Cowling examines an alternative hypothesis, that the sun's general field may be due to thermal effects in a rotating mass—a view advanced by W. M. Elasser in 1939 to explain the earth's magnetic field. On developing this theory it is found that the results, while giving a field of the correct sign, give less than 10^{-7} of the observed field. The question arises whether the small field due to thermal currents may not be magnified by dynamo action, due to the circulation of material in meridian planes. This hypothesis, however, must be rejected, because it would require a time equal to $1 \cdot 6 \times 10^{18}$ years to produce the present field in the sun. Other possible explanations are briefly considered, including the view that the material in the far interior of the sun is capable of permanent magnetization; and although it requires that a very hot and ionized material is capable of acquiring a regular, crystal-like structure—a possibility usually disregarded—nevertheless Cowling thinks that it is worthy of further investigation, in view of the difficulties of other hypotheses.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, NEW ZEALAND

ANNUAL REPORT

THE nineteenth annual report of the Department of Scientific and Industrial Research, New Zealand (Wellington: Government Printer. 1*s.* 6*d.*), covers the year 1944–45, and includes the Minister's statement, the secretary's report and reports of the Research Committees of the Council as well as of the Cawthron Institute, the work of the Dominion Laboratory, Observatory and Physical Laboratory, the Geological Survey and Magnetic Observatory, the Meteorological Branch and research work at Canterbury and Massey Agricultural Colleges.

Research during the year under the Building Research Committee embraced the study, and methods of control, of timber-infesting insects and fungi, carried out by the Plant Diseases Division, the Entomology Division and State Advances Corporation; the causation and control of mould infestation in houses; investigations of a system of prefabrication in standard concrete and light-weight (pumice) concrete and a review of literature on the acoustics of building, preparatory to carrying out experimental work with particular reference to multiwall units. The Committee also considered a report by the New Zealand Institute of Architects on proposals for earthquake reconstruction in earthquake danger zones, and recommended a national survey of all buildings to determine their structural stability under earthquake stress.

The Dairy Research Institute continued its work in collaboration with the Entomology Division of the Plant Research Bureau on the control of cheese-mite; trials with dichloroethyl ether have shown great promise as a means of control in curing rooms. Isolated starter-rooms and other devices designed to exclude airborne bacteriophage infection of starter culture for cheese manufacture continued to give success in the maintenance of cultures. Trouble due to failure of acid development in the cheese vat still occurs due to infection of the factory equipment and infection of the milk delivered from cans which have been used for the transport of whey. The former infection is easily checked by chlorinating the vats, pasteurizer and piping, but the contamination of the milk cans is much more difficult to eliminate. Chlorination of the whey proved practicable but costly. Other investigations covered the effect of the feeding of cows on the characteristics of cheese, milk, dairy cow nutrition and growth-hormone studies, and the value of various irrigants in the treatment of mastitis.

The Food Preservation and Transport Advisory Committee's investigation on the refrigerated gas storage of apples, superficial scald on Granny Smiths, the influence of rootstock and intermediate scion on core-flush in Granny Smiths and the effect of fertilizers on the cold-storage quality of apples were taken a stage further. Fruit research included long-term manurial investigations, small-scale trials of D.D.T. and other insecticides for control of carrot aphids, red-mite, codling moth, etc.

A Manufacturer's Research Committee was established to survey the present state of New Zealand manufacturing industry in the light of modern scientific developments, to consider plans for concerted efforts to meet the demands of the post-war period, as well as methods for the application of science in development, extension and modernization of existing industries and to encourage the formation of research associations in appropriate industries, the employment of technical assistance in industry and the investigation of particular industrial problems by the Department of Scientific and Industrial Research or other scientific institutions.

In the Plant Chemistry Laboratory the preservation of food by dehydration received most attention, vegetables and apples being the subject of most of the work, though some work was carried out on stone-fruits and with pears. Work continued at the Plant Research Bureau on linen flax, and in the Botany Division on seaweed resources and weed investigations. Plant disease investigations by the Plant Diseases Division covered the bacterial wilt of beans, carrot rust-fly and tests of inert dust to protect stored grain from weevil attack, as well as preliminary work on the production of penicillin. The Wheat Research Institute evolved a new wheat strain, equal in yield to Cross 7 but with a considerably higher baking score and protein content, while milling practice was improved so as to ensure higher food value being secured from the flour produced. Tobacco research resulted in a considerable measure of control being secured in the field over mosaic disease, and showed that high-quality seed can be produced locally, rendering New Zealand independent in this respect.

An important experiment in North Auckland in evaluating the soil maps in relation to the factors concerned in economic management, production and potential land use showed that the soil survey has enormous potentialities. At the Cawthron Institute, in addition to soil survey work, tomato investigations included the use of steam and formaldehyde for treating glasshouse soil and tests of soil disinfectants on outside tomato soil. At the Canterbury Agricultural College the effect of fertilizer treatment on the production of subterranean clover continued. Entomological investigations there included sheep-dipping trials, trials for the control of stem weevil and Hessian fly on wheat. At the Massey Agricultural College sheep nutrition experiments have continued both as research into animal nutrition and on the parasitology of sheep.

As a result of discussions on the functions of the Dominion Physical Laboratory, it has been recommended that the post-war function of this Laboratory should be such that its decision on physical matters of precision, quality and performance be accepted as final; its functions are more specifically stated as general research and development of a physical and engineering nature; calibration and repair and general testing of civil, mechanical and electrical equipment; work for the New Zealand Standards Institution and general physical testing of goods and commodities and the custody and control of the legal physical standards of measurement. A feature of the year's work was the increasing number of requests for assistance made to the Laboratory by industry.

RADIO FREQUENCY MEASURING TECHNIQUE

RECENT issues of the *Proceedings* of the Radio Section of the Institution of Electrical Engineers, forming Part III of the *Journal* of the Institution, contain several papers describing advances in the technique of measuring various electrical quantities at increasingly higher radio frequencies. Another series of papers was read at the Radiolocation Convention held by the Institution; and the publication of these in the near future will be awaited with interest.

The measurement of frequency itself in the range 100–10,000 Mc./s. is dealt with in a paper by Dr. L. Essen and Mr. A. C. Gordon-Smith published in the December issue of the *Proceedings*. This paper is an official communication from the National Physical Laboratory and describes how the usual heterodyne methods of measuring a frequency by comparison with an appropriate harmonic of a standard quartz oscillator can be extended to the highest frequencies now in general use. A self-contained portable apparatus is described, incorporating both a quartz-controlled oscillator and two interpolating oscillators, the whole set, excluding the power supply equipment, weighing about 30 lb. A measurement of an unknown frequency can be made in a few seconds, so that the frequency drift of the interpolating oscillators is very small. The accuracy of measurement in terms of the frequency of the quartz oscillator is $\pm$ 1 part in 10^9; but for an overall accuracy of this order, it is usually necessary to check the frequency of the quartz oscillator.

Another paper in the December issue of the *Proceedings*, by Mr. R. F. Proctor and Dr. E. G. James, describes a radio-frequency capacitance and conductance bridge which operates at a frequency of 1 Mc./s. This bridge is suitable for the measurement of capacitances from 0 to 28 $\mu\mu F_2$ and parallel conductances from 0 to 11 micromhos (90,000 ohms). One side of both the generator and the detector is earthed, and the bridge has the great advantage that the capacitance between earth and each electrode of the partial capacitance being measured does not affect the balance condition. The design of the bridge lends itself to operation at frequencies up to 50 Mc./s., provided that the usual precautions are taken with regard to residual capacitances and inductances.

The numerous war-time applications of centimetric waves gave rise to the need for developing new techniques for measuring the properties of dielectric materials at extremely high frequencies, with particular reference to low-loss materials such as polythene and polystyrene. At frequencies above 100 Mc./s., lumped resonant circuits become increasingly difficult to devise and operate, and they are consequently replaced by resonant elements of either transmission lines or wave guides. The theory and experimental development of such techniques suitable for frequencies of more than 600 Mc./s. (wave-lengths less than 50 cm.) are described in a paper entitled "Resonance Methods of Dielectric Measurement at Centimetre Wavelengths", by Messrs. F. Horner, T. A. Taylor, R. Dunsmuir, J. Lamb and Prof. Willis Jackson, and published in the January issue of the *Proceedings*. The relative suitability of three forms of resonator, one a short-circuited length of coaxial transmission line, and the other two cavity-resonators operating in different modes, is discussed. It is shown that for dielectric measurements, complete filling of the resonators with dielectric is unnecessary, a conclusion which has considerably facilitated the experimental work on solid dielectrics. The paper contains a description of apparatus used for measurements at frequencies of about 3,000 Mc./s. (wave-length 10 cm.) and a statement of typical experimental results obtained with a specimen of polythene, which at the above frequency had a permittivity of 2·27 and a power factor of 0·0004. The accuracy attainable in such measurements is discussed in the paper.

The March issue of the *Proceedings* contains a paper entitled "Radio Measurements in the Decimetre and Centimetre Wavebands", by Mr. R. J. Clayton, Drs. J. E. Houldin and H. R. L. Lamont, and Mr. W. E. Willshaw; and this describes a wide field of radio-frequency measuring technique as it evolved in the Research Laboratories of the General Electric Co., Ltd. Such a technique was a necessary aid to the development of valves, circuits and equipment required during the War for increasingly higher frequencies; and the paper begins with a review of the circuit theory of coaxial and wave-guide transmission lines, followed by a short discussion of high-frequency oscillators. Succeeding portions of the paper deal with the measurement of the fundamental quantities of frequency, power, impedance, voltage and current. The concluding sections of the paper are concerned with measurements derived from the above quantities; such as receiver sensitivity, aerial gain and impedance, and radio field-strength. Descriptions are given of some of the practical equipments developed for these measurements; and the discussion which took place at the reading of the paper before the Radio Section of the Institution, brought to light some information on similar work which has been in progress elsewhere in Britain during the war years.

CIVIL ENGINEERING AS A CAREER

THE Institution of Civil Engineers has given a fine lead to other professions in its recently published brochure entitled "Civil Engineering as a Career". With the ever-increasing width of human activity, the percentage of young men who can have anything but an elementary idea of the kind of life to which their chosen job is going to lead them must be small, and here in compact but fully informative form is an admirably drawn picture of a profession, rightly encouraging, but without any trace of propaganda. It merits the most careful study by anyone whose responsibilities entail advising scientifically inclined young men what lies open to them. It should certainly be in the hands of every young engineer in his early days at the university, when he is faced with the choice of what branch of the profession he is going to adopt.

The excellence of this publication must not blind one, however, to a serious disadvantage from which civil engineering seems to suffer, and which is somewhat of a high price to pay for the undoubted interest and satisfaction to be found in this branch of the profession. This disadvantage is the lack of security, not in earlier years, of course, when a young man's thoughts should be turned towards fitting himself for the high responsibilities ahead, but later on when most men have home responsibilities. Civil engineering is a profession of high adventure, but high adventure normally signifies high reward for those

with the courage and spirit to see it through, and it is very doubtful if such reward falls to the lot of the reasonably successful civil engineer.

Civil engineering is, if we may use the mathematical analogy, the second differential of the profession, the aim of which is the acceleration of normal progress; and in the earlier years of this century when everything was alive with expansion, there was no doubt in the truth of the statement that a civil engineer could walk the length of Victoria Street, London, and find himself with a dozen excellent assignments to choose from. Those good days are, however, past, and we live in more sober times, added to which the 'dynamic' side of engineering has made immense strides both in the width of its products and in their application to industry. What could offer higher adventure than the development of the jet engine, or radar; or the smooth and effective running of a complicated human machine such as a works of some thousands of hands, with all the problems of production control and the enjoyment of the command of men: and with all this, more security of tenure and, we think, very appreciably greater financial reward? Higher executives in engineering firms or industry can look to salaries of £1,000–£1,500 or more from about the age of thirty-five onwards, a level which we doubt can be expected by a resident civil engineer of comparable age, technical training and experience.

This, then, is the competition which civil engineering has to face. The insecurity, save for the fortunate few who may perhaps become partners in a firm of repute, seems inevitable. Manufacturing industry is a continuous process, slow or fast maybe, but in steady motion, whereas big public works are dependent for their life on a wide variety of circumstances and are the first to be hit by any period of depression. May it be hoped, therefore, that to attract to this branch of the profession the best young men, as it well deserves, the rewards will be very real. Consultants' expenses are high, but surely on a contract totalling some hundreds of thousands of pounds a rise in the price of that essential raw material, namely, the resident engineer's skill and devotion, would scarcely make an appreciable difference.

Certain branches of civil engineering are of the 'service' type, with a planned career, but we are not sure even here whether the terms offered are fairly aligned with those in other careers of a similar nature. It might not be unwarranted to draw an analogy between such careers and the financial world, where the yield of government securities largely regulates the gilt-edged market. This analogy is pointed by the terms recently offered by the Government Scientific Service, designed to attract the best material of Britain to a career which cannot offer more than a fair reward compatible with security and pension. It would be extremely interesting to compare these with the prospects ahead of a young engineer in, say, one of the railways.

Civil engineering suffers from a further disadvantage at the other end of the scale, namely, the conditions of entry. Criticism on this count is now, to some extent, disarmed by the reference on page 12 of the brochure to recent arrangements made between the Institution of Civil Engineers and both the Institution of Municipal and County Engineers and the Federation of Civil Engineering Contractors, for the proper training of young engineers entering the profession through these two latter channels. We understand, although it is not mentioned, that the scheme envisages a salary of the order of £250–£300 a year for a two-year indenture. This is a most excellent move on which the Institution of Civil Engineering is to be congratulated, the level being approximately the same as that now offered by the big 'training' firms in the electrical and mechanical world. Contracting and municipal engineering are, however, only branches of civil engineering so to speak, and it is a matter of some regret that the lead in improved conditions for training has not been given by the 'core' of the profession, namely, the consultants. The chapter on consulting engineering includes only a somewhat vague and unsatisfactory reference to the proper method of entry, together with an ominous, and surely unnecessary, warning of the perils of aiming at too high a salary in early years. The young engineer of to-day is a young man with a very realistic view of life and a readiness to learn his craft thoroughly—provided it does not entail his being a burden on his heavily taxed parents.

BOMBYLIIDÆ OR BEE FLIES OF EGYPT

THE Bombyliidæ or bee flies are very well represented in a warm, sunny country like Egypt. They are an exceptionally interesting group of Diptera to the entomologist, not only on account of the remarkable range of form displayed by the adult flies but also owing to the curious parasitic habits of their larvæ. Prof. Efflatoun Bey has recently made a very detailed study of the Egyptian species*, and the results of his labours form Part VI of his well-known "Monograph of Egyptian Diptera".

The Bombyliidæ are poorly represented in cold or cool countries, but they rapidly increase in number of species as we pass southwards. Thus, the author mentions that while there are only nine British species and fourteen Danish forms, some sixty kinds are recorded by Schiner from Austria and 115 from Spain. In 1924, 594 species were known from the Ethiopian region, and that number is only a small proportion of those that probably remain still to be discovered. In 1919, fewer than fifty species of bee flies were known from Egypt, but to-day that number is more than quadrupled. For reasons of economy and convenience, the results of Prof. Efflatoun's study are to appear in two parts. The present, or Section I, deals with the Bombyliidæ Homœophthalmæ or those in which the compound eyes are simple, that is, not indented on the hind margin. Section II, dealing with the Bombyliidæ Tomophthalmæ, or those in which the eyes are evidently indented, will, it is hoped, be published in the near future. A series of beautiful coloured plates have characterized the previous parts of this monograph, and their absence from the present section immediately attracts notice. Prof. Efflatoun mentions that they cannot be published at present owing to difficulties arising out of the War, but it is expected that they will be issued later. On the other hand, the work is very well illustrated by some 38 black-and-white plates comprising more than 550 well-drawn figures of structural details pertaining to the different species.

At the present time nothing is known concerning the early stages of these flies in Egypt, and here a wide field of inquiry awaits a competent investigator.

* A Monograph of Egyptian Diptera. Part VI. Family Bombyliidæ. Section I. By Prof. H. C. Efflatoun Bey. *Bull. Soc. Fouad 1er d'Entomologie*, pp. 482+38 pl., 1945.

Elsewhere it is known that a number of species attack one or other kind of migratory locust in the egg stage. Other Bombyliidæ parasitize the caterpillars of moths or the larvæ of solitary bees and fossorial wasps. Fabre, for example, gave an interesting account of a species that lives at the expense of the mason bee. One species has been bred from the puparia of tsetse flies (*Glossina*) and others are hyperparasites.

In Prof. Efflatoun's opinion the systematic arrangement of the Bombyliidæ still awaits a competent monographer, notwithstanding the labours of such authorities as Becker and Bezzi. The limits of some of the subfamilies are by no means well defined and the allocation of various genera is open to doubt. Possibly, as Bezzi originally suggested, a closer knowledge of the bionomics and ethnology of the family will lead to a better taxonomy. The Bombyliid fauna of Egypt, as with many other families, undoubtedly forms, according to Prof. Efflatoun, a connecting link with the Palæarctic and Ethiopian zoogeographical regions. A. D. IMMS

RECONSTRUCTION IN THE ASSAM HILLS

THE process of reconstruction must vary in different localities, but in most cases the anthropologist can be of real assistance. In his presidential address for 1945 to the Royal Anthropological Institute of Great Britain and Ireland, Prof. J. H. Hutton discussed some problems of reconstruction as they will appear in the Assam Hills. Any hill-tribe tends to lead a more or less segregated life, and until this century the Nagas had had only sporadic communication with the outside world. The First World War was responsible for a certain amount of contact, but it was not until the recent campaign in their country that any large-scale opening-up occurred. Now there are good roads, and communication by air is also established.

Communications, with the labour necessary to maintain them, will mean a steady flow of money, in the form of wages, into the country ; and with the further opening-up of Burma and Assam, the Nagas will inevitably have to relinquish their position of isolation. Indeed, one curious result of the Japanese invasion was that it gave the Nagas a feeling of partnership with the other peoples who were fighting the common foe, and proved them most loyal and helpful to the Allies.

In return for this, it behoves us to see that the changes that have been wrought so suddenly should be beneficial and not detrimental to this fine race. They have an intense love of independence. They are asking for education ; but it must be the right sort and benefit the whole community, rather than create a class of minor clerks who will try to exploit the less bookish members.

Another problem concerns the administration of the district : to what degree the Nagas are capable of indirect rule, and how far collective responsibility may be a workable proposition. Then, too, there is the language question, for example, whether the higher education should be given in English or Assamese ; and if the latter, which of the several dialects should be used and reduced to writing. Cultivation of the hill country is another important question : removal of the forests reduces the rainfall necessary for the irrigation of the terraces which have replaced the tree-covered slopes, thus setting up a vicious circle from which there seems no escape since rice is a staple food.

These, then, are some of the problems of this area, a comparatively small one, and similar problems on a larger scale await solution in practically all south-east Asia, Indonesia and Oceania. The need for applied anthropology is unquestionable. Changes there are, and must increasingly be, and it is the duty of those responsible for administration to see that the welfare of indigenous peoples is the first consideration. K. R.

LAMARCK BICENTENARY CELEBRATIONS

CELEBRATIONS in honour of the bicentenary of the birth of Lamarck were held in Paris during June 15–18, under the auspices of the Muséum National d'Histoire Naturelle, the Société Zoologique de France and the Société Botanique de France. A number of foreign guests were invited, and included representatives from Belgium, Denmark, Great Britain, Holland, Mexico, Portugal and Switzerland.

The proceedings started on June 15 by an inaugural session in the great amphitheatre of the Museum under the chairmanship of the Ministre de l'Education Nationale. The chief events in the life of Lamarck were traced by M. A. Urbain, director of the Museum ; M. H. Humbert spoke of Lamarck's contributions to botany, and M. R. Jeannel of his services to zoology ; Prof. M. Caullery reviewed the significance of Lamarck's work from the point of evolution, and assessed the position which it occupies to-day.

The morning of June 16 was devoted to a demonstration of exhibits relating to the life of Lamarck ; a charming and interesting feature of the occasion was the presence of representatives of Lamarck's family, in the persons of his great-great-grandsons. A wreath was laid at the foot of Lamarck's statue, and the delegates then attended a banquet presided over by the Directeur des Rélations Culturelles of the Ministère des Affaires Étrangères. In the afternoon the delegates were taken over the Musée de l'Homme by its founder and director, M. Rivet.

On June 17, the delegates were taken to the Zoological Park at Vincennes, where they had the opportunity of seeing many interesting animals and of learning of the difficulties encountered—and largely surmounted—in obtaining food for them. After enjoying the wonderful view from the top of the Grand Rocher, the delegates were entertained to luncheon by their hosts under the chairmanship of the Directeur de L'Enseignement Supérieur of the Ministère de L'Education Nationale. After returning to Paris the delegates attended a reception at the Laboratoire d'Evolution des Etre Organisés.

From this point, the programme was divided, and the delegates attended meetings of the Société Zoologique and of the Société Botanique, respectively, including demonstrations and communications.

The proceedings were marked by the greatest cordiality, and the trouble taken by the organisers in the face of considerable difficulties as regards food and accommodation was deeply appreciated by the visitors, who were very grateful for the opportunity to renew old friendships and make new ones while paying tribute to the name of Lamarck.

FORTHCOMING EVENTS

Monday, July 8

BRITISH ASSOCIATION (joint meeting with the ROYAL SOCIETY EMPIRE CONFERENCE, at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Conference on "Dissemination of Scientific Information to the Public".

Thursday, July 11

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. C. N. Hinshelwood, F.R.S.: "The More Recent Work on the Hydrogen-Oxygen Reaction" (Bakerian Lecture).

Tuesday, July 9—Thursday, July 11

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1), at 10 a.m. each day.—Conference on "X-Ray Analysis during the War Years".

Tuesday, July 9—Saturday, July 13

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Tunbridge Wells).—Jubilee Congress.

Tuesday, July 9, at 8.15 p.m. (at the Council Chamber, Town Hall).—Prof. J. D. Bernal, F.R.S.: "The Place of Scientific Societies in the New World" (Presidential Address).

Thursday, July 11—Saturday, July 13

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the Physics Department, The University, Oxford Road, Manchester 13).—Conference on "The Measurement of Stress and Strain in Solids". (Thursday, at 2 p.m.; Friday, at 9.30 a.m.; Saturday, at 9.30 a.m.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSIOLOGY AND ZOOLOGY—The Registrar, Technical College, Sunderland (July 13).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT, a LECTURER IN THE MATHEMATICS DEPARTMENT, and a LECTURER IN THE NATURAL PHILOSOPHY DEPARTMENT—The Secretary, Royal Technical College, Glasgow (July 13).

LECTURER IN MATHEMATICS, PHYSICS AND CHEMISTRY for National Certificates, Matriculation and Intermediate Science courses, at the Oxford School of Technology—The Chief Education Officer, 77 George Street, Oxford (July 13).

LECTURER IN PHYSICS AND MATHEMATICS at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick (July 13).

LECTURER and an ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, University College, Gower Street, London, W.C.1 (July 15).

LECTURER IN ELECTRICAL MACHINERY AND DESIGN—The Registrar, College of Technology, Manchester 1 (July 15).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS, preferably with qualifications in Pure Mathematics—The Registrar, University College, Hull (July 16).

HEAD OF THE DEPARTMENT OF HORTICULTURE, and an ASSISTANT LECTURER IN AGRICULTURE, at the Yorkshire Institute of Agriculture, Askham Bryan—The Joint Clerk, Yorkshire Council for Agricultural Education, County Hall, Beverley, Yorks. (July 17).

LECTURER and an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7 (July 17).

PROFESSOR OF CHEMICAL TECHNOLOGY, an ASSISTANT PROFESSOR OF PRODUCTION METALLURGY, LECTURERS (4) on PHYSICAL METALLURGY, ELECTRO-METALLURGY, FUELS, and MINERALOGICAL CHEMISTRY, an ASSISTANT PROFESSOR and a LECTURER IN THE DEPARTMENT OF INTERNAL COMBUSTION ENGINEERING, an ASSISTANT PROFESSOR and a LECTURER IN HIGH VOLTAGE ENGINEERING, at the Indian Institute of Science, Bangalore—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (July 20).

STATISTICIAN for the Agricultural Development Scheme, Nigeria (candidates must have an Honours Degree in any of the Natural Sciences or Agriculture, and post-graduate training in Agriculture or similar statistics as applied to research)—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting Order No. G.209/AO (July 20).

ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (July 20).

LECTURER IN PSYCHOLOGY—The Registrar, The University, Manchester 13 (July 22).

CHIEF OF THE DIVISION OF TEXTILE RESEARCH, Council for Scientific and Industrial Research—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (July 27).

ASSISTANT RESEARCH ENGINEERS (3, Honours University degree essential, with preferably post-graduate training and some experience in Chemical Engineering, Steam Boiler Plant, Gas Dynamics, or Electrical Machinery)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting Plant Engineering Division (July 31).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Sheffield (July 31).

STATISTICIAN to assist in the application of statistical methods to the problems of Horticultural Field and Laboratory experiments—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 1).

ARTIST (whole-time) IN THE ANATOMY DEPARTMENT to undertake drawings from whole specimens and microscope slides, and the preparation of diagrams—The Secretary, University College, Gower Street, London, W.C.1 (August 1).

CURATOR OF THE ANATOMY MUSEUM—The Secretary, University College, Gower Street, London, W.C.1 (August 1).

BASHFORTH PROFESSOR OF MATHEMATICAL PHYSICS at the Military College of Science—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, endorsed 'M.C.S.', and quoting No. 1517 (August 19).

ENTOMOLOGISTS (2) for the Research Division, Department of Agriculture and Forests, Sudan (for investigation of and control measures against crop pests including locusts)—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist'.

ORGANIC CHEMIST (with Ph.D. Degree or equivalent) for work in the Development Department at Welwyn Garden City—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

PRINCIPAL of a new Institute of Jute Technology to be established in Calcutta for the scientific and technical training of Indian mill personnel—The Secretary, Indian Jute Mills Association, Research Institute, Imperial Institute, South Kensington, London, S.W.7.

SCIENTIFIC INSTRUMENT MAKERS (2, one supervisory grade and one grade I), and a LABORATORY STEWARD (supervisory grade)—The Professor of Physics, Birkbeck College, Breams Buildings, London, E.C.4.

PHYSICAL CHEMIST and a BIOCHEMIST—The Director of Research, Research Association of British Flour Millers, Cereal Research Station, St. Albans, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 63: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, Part 9. The Primary Thermal Oxidation Product of Ethyl Linoleate. By J. L. Bolland and H. P. Koch. Pp. 4. (London: British Rubber Producers' Research Association, 1945.) [1912

Is It Nothing to You? By Victor Gollancz. Pp. 16. (London: Victor Gollancz, Ltd., 1945.) 4*d*. [1912

Association of University Teachers. Report on University Developments, Part 3. Comprising the Universities and the Education of Teachers; The International Functions of a University. Pp. 8. (Bristol: J. W. Arrowsmith, Ltd., 1945.) 1*s*. [1912

Ministry of Supply. A First Guide to Quality Control for Engineers. Pp. 38. (London: H.M. Stationery Office, 1945.) 1*s*. net. [31

A. Sc. W. Memorandum. Trades Union Congress, Blackpool, September 1945: Delegates' Report. Pp. 16. 3*d*. Information Leaflet No. 1: Executive Statement on the Atomic Bomb. Pp. 4. (London: Association of Scientific Workers, 1945.) [31

Chelsea Polytechnic, 1895–1945. Pp. 8. (London: Chelsea Polytechnic, 1945.) [31

Physical Society. Catalogue of the Thirtieth Exhibition of Scientific Instruments and Apparatus, January 1946. Pp. 288 + lxxxviii. (London: Physical Society, 1946.) 2*s*. net. [31

Other Countries

Northern Rhodesia. Report on the Development of Secondary Industries in Northern Rhodesia. By Dr. W. J. Busschau. Pp. 91. (Lusaka: Government Printer, 1945.) 2*s*. 6*d*. [2211

Geological Survey of Uganda. Water Supply Paper No. 1: Water Boring in Uganda, 1920–1940. By C. B. Bisset. Pp. 32. Water Supply Paper No. 2: Small Reservoirs in Uganda. By C. B. Bisset. Pp. 44. 2*s*. 6*d*. (Entebbe: Government Printer, 1945.) [2211

Museums Trustees of Kenya. Annual Report for the Year 1944 of the Museums Trustees of Kenya and of the Coryndon Memorial Museum, Nairobi. Pp. 7. (Nairobi: Coryndon Museum, 1945.) [2211

Yale University School of Medicine. Fifth Annual Report of the Historical Library, June 30, 1945. Pp. 34. (New Haven, Conn.: Yale University School of Medicine, 1945.) [2211

Cawthron Institute. Annual Report, 1944–5. Pp. 31. (Nelson, New Zealand: Cawthron Institute, 1945.) [2211

Survey of India. Civil Activities Report, War Period (1939–45 up to 31.3.45.). Pp. 10. (Dehra Dun: Survey of India, 1945.) [2211

Supplement to the American Ephemeris, 1946: Tables of Sunrise, Sunset and Twilight. Pp. 196. (Washington, D.C.: Government Printing Office, 1945.) 75 cents. [2211

Acta Pharmacologica et Toxicologica. Vol. 1, Fasc. 1. Pp. 128. Vol. 1, Fasc. 2. Pp. 129–224. (København: Einar Munksgaard, 1945.) 35 kr. per Vol. (4 parts). [412

Carnegie Corporation of New York. Report of the President, the Secretary and the Treasurer for the Year ended September 30, 1945. Pp. 71. (New York: Carnegie Corporation, 1945.) [1312

Union géodésique et géophysique internationale. Travaux de l'Association Internationale de Géodésie. Tome 15, Fascicule 1. 15 rapports. (Paris: Association Internationale de Géodésie, 1939.) [1312

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1940. Pp. iii + 104 + 4 plates. Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1941. Pp. xxxvi + 188 + 5 plates. (Bern: Paul Haupt, 1941–1942.) [1312

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 120 Jahresversammlung vom 28 bis September 30, 1940 in Locarno. Pp. 524 + 54 + 11 plates. 121 Jahresversammlung vom 6 bis 8 September 1941 in Basel. Pp. 438 + 16 plates. (Aarau: H.R. Sauerländer et Cie., 1940–1941.) [1312

University of Bombay: Department of Chemical Technology. Annual Report, 1944–45. Pp. iv + 43. (Bombay: University of Bombay, 1945.) [1312

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PLANNING NEW TOWNS FOR BRITAIN

THE publication of a new edition of Ebenezer Howard's book, "Garden Cities of To-morrow"*, should be welcomed by all those who are attempting to take an impartial view of the debate on new towns in Britain, on which the choice of Mobberley as the nucleus for Manchester's first satellite town has sharply focused public attention and which has since been extended by the appearance of the two interim reports of the New Towns Committee and the subsequent introduction of the New Towns Bill. To the new edition, moreover, have been restored some of the quotations which were discarded from the revised edition of 1902 but which have fresh interest to-day. The preface by Mr. F. J. Osborn, and Mr. Lewis Mumford's introductory essay on "The Garden City Idea and Modern Planning", add to its value in the formation of a sound and independent opinion on the present issues, as well as assist the reader to an appreciation of the magnitude of Howard's contribution to the modern town-planning movement.

Howard's prime contribution, as Mr. Mumford points out, was to outline the nature of a balanced community and to show what steps are necessary in an ill-organised and disoriented society to bring it into existence. He saw rural and urban improvement as a single problem, and he believed consistently in the experimental method. His method was in the best and most characteristic tradition of British statecraft, using to the utmost solid political traditions in preparing the way for change by common consent. It is well that a fresh opportunity should be given us of studying for ourselves his ideas and method and proposals, and not what others have represented him as saying.

Mr. Mumford's essay emphasizes the way in which Howard's ideas have laid the foundation for a cycle in urban civilization in which the means of life will be subservient to the purposes of living, and in which the pattern needed for biological survival and economic efficiency will likewise lead to social and personal fulfilment. That is an idea which Mumford's own writings have done much to spread, and which is notably formulated in his pamphlet "The Social Foundations of Post-war Building". "Good planning, in the post-war age, will rest on the solid foundations of the family and the region ; it will emphasize the biological and the social needs of the people, and it will treat industrial and financial needs as subordinate ones." Those words of Mumford's might well have received greater attention in recent House of Commons debates on the subject, where there was little appreciation shown of the bearing of the Welwyn and Letchworth experiments upon either the birth-rate or the mortality.

Sir Ebenezer Howard's contribution is, however, brought out very clearly by Mr. F. J. Osborn in his own new book, "Green-Belt Cities : the British

* Garden Cities of To-morrow. By Ebenezer Howard. Edited, with a Preface, by F. J. Osborn. Pp. 168+8 plates. (London : Faber and Faber, Ltd., 1946.) 6s. net.

Contribution"*, in which, after assessing Howard's contribution, Mr. Osborn reviews the experience gained at Welwyn and Letchworth in its bearing on the current debate on the size of towns and the disposition of towns in relation to the countryside. The main components of Howard's garden city idea are, according to Mr. Osborn, first, the organised outward migration of industries and people to towns of sufficient size to provide the services, variety of occupations, and level of culture needed by a balanced cross-section of modern society. Next come the limitation of size; the provision of amenities; the definition of the town area and permanent reservation of a large area around it for agriculture; planning control; neighbourhoods; unified land-ownership; and municipal and co-operative enterprise, without abandoning general individual freedom in industry and trade. Like Mumford, Mr. Osborn emphasizes Howard's practical judgment and technique and the soundness of his economic set-up; and the first chapter of his book should send the reader to Howard's own book for first-hand study.

Mr. Osborn's book, however, itself makes a valuable contribution. He traces the submerging of Howard's idea in the planning thought of the period between the World Wars, and the significance both of Howard's book and the Barlow Report for the new situation which opened up with the bombing of the cities of Britain in the winter of 1940–41. Sir Patrick Abercrombie's Greater London Plan of 1944 is described as a modern application of Howard's principle of social cities; and, examining in detail the experience gained at Letchworth and Welwyn in regard to the physical pattern, the use and control of the land, problems of administration, local government and finance, and of social life and culture, he proceeds finally to discuss its bearing on the green-belt cities of the future.

There is no more vital part of Mr. Osborn's argument than that which links up the present policy of building new towns with the principles of urban development recommended by the Barlow Commission. The location of industry and the dispersal of population are two facets of one problem. By cautious stages between 1941 and 1945 the Government has accepted the three principles of the Barlow Report: continued and further development of congested urban areas, where necessary; decentralization or dispersal, both of industries and industrial population, from such areas; and encouragement of a reasonable balance of industrial development, coupled with appropriate diversification of industry in each division or region throughout the country. What stands out from this book, nevertheless, is the failure of the Government to provide as yet the effective machinery by which the new opportunities which the War brought through the destruction caused by bombing, evacuation, dispersal and transfer of workers and industries can be seized. Mr. Osborn's recital of experience at Letchworth and Welwyn refutes completely the idea that purely negative control is adequate, just as Howard's emphasis on the importance of acquisition of the whole site at the start by the development body, so that improvements accrue to the development authority, is a warning of the grave danger involved in further delay in dealing with the crucial problems of compensation and betterment.

Much of the argument in Mr. Osborn's final chapter on ways and means of dispersal runs parallel with that of the First Interim Report of the New Towns Committee, but somewhat counter to the Bill introduced by the Minister of Town and Country Planning. Powers of initiative, guidance and veto, he holds, should be in the hands of a central department capable of balancing, from the national point of view, the complex of social, economic, strategic and æsthetic considerations involved. Nor is it only in the matter of new towns and urban development that these questions of balance and positive guidance as well as veto arise. The Wentworth–Woodhouse case is a dubious example of the unsatisfactory arrangements for co-ordination among the departments concerned with building and planning. The decision of the London County Council, to which attention was directed in the debate on housing in the House of Commons, to violate the Abercrombie plan by breaking into the green belt at Chessington with a large housing estate, reveals how much, in the present state of affairs, the face of the country remains at the mercy of practical developers, public as much as private. One such threat has been removed by the recent rejection in the House of Lords of the Leicester Corporation's proposals for a reservoir in the Manifold valley, though it is improbable that the decisive consideration was that the nation's interest in a Peak District national park should outweigh Leicester's interest in extending its water supply at the least inconvenience to itself.

Meanwhile, other such threats to the Lake District, already scheduled for reservation as a national park by the Dower Committee, still persist, both from the unilateral and co-ordinated plans of local authorities in Ennerdale and at Loweswater, for example, and, as the strong protests voiced at a meeting on May 15 held by the Council for the Preservation of Rural England show, from Government departments also. In other areas scheduled for consideration as national parks there is as yet no indication of withdrawal; for example, Dartmoor, Exmoor, the North Pennines, Harlech, the New Forest and Redesdale. Furthermore, the nature of some of the opposition to the Stevenage proposal, in spite of its designation in the Abercrombie plan and the specific recommendation of the Reith Committee, is evidence of the prejudice which any policy of urban development or the preservation of amenity will encounter, and of the necessity of the task of the education of public opinion for which these books are so well designed.

Mr. Osborn leans to a population limit of 30,000–50,000 for the new towns as against the 20,000–60,000 people suggested in the first interim report of the Reith Committee. Considering the new towns as intended primarily to take the overspill of conurbations like Manchester, these are probably too

* Green-Belt Cities: the British Contribution. By F. J. Osborn. Pp. 191 + 12 plates. (London: Faber and Faber, Ltd., 1946.) 12s. 6d. net.

low: a population of 75,000 or so is required to provide the desirable economic, cultural and social compensations. As regards ownership, Mr. Osborn prefers public ownership; but the essential requirement is to plan the whole area so as to secure the proper safeguarding of agricultural land and the preservation of the countryside, as well as the efficient utilization of all the land, and to provide for acquisition of sites by compulsory purchase. But in contrast to the Ministry of Town and Country Planning, and more emphatically than the New Towns Committee, he would entrust the promotion and building of new towns to several types of development authority, including local authorities, private enterprise and co-operative societies. Whatever the type of authority, however, he insists that without a solution of the problem of compensation and betterment, adequate control of land use is impossible. The importance of providing the essential services as early as possible is recognized, as is that of the contribution of skilled teams of planning experts. The impingement of the problem on revision of local government boundaries is recognized without being overstressed. Mr. Osborn's main point is that the planning and development of new towns is not an enterprise for the amateur or for the narrowly specialized technician without social interests or experience; it demands the close co-operation of the technician with business men and men versed in public affairs. Our schools of architecture and university courses in statutory town planning and estate management need supplementing, he suggests, with schools or university courses in town development, and that Welwyn Garden City is an obvious place for such a school.

Mr. Osborn's book was in proof when the appointment of a New Towns Committee, under the chairmanship of Lord Reith, was announced. The terms of reference of this Committee are: "To consider the general questions of the establishment, development, organisation and administration that will arise in the promotion of New Towns in furtherance of a policy of planned decentralisation from congested urban areas; and in accordance therewith to suggest guiding principles on which such Towns should be established and developed as self-contained and balanced communities for work and living". Already two interim reports have come from the Committee, and they indicate that the fundamental ideas of Howard and Osborn are finding fresh expression, even if in some respects that is better shown in the reports themselves than in the Bill which has followed. Public interest has been stimulated equally by the controversies over the proposals for dealing with Manchester's overspill in a new town at Mobberley, or the even larger overspill problem of Liverpool, apart altogether from the pressure which comes from the necessity of a firm national decision on such planning problems as those involved in the development of Oxford, or Knutsford, or Stevenage.

The first interim report of the Reith Committee distinguishes two types of new towns: those that are entirely new, planned and built where there was previously only a scattered and rural population; and those that are major extensions of existing small towns. The Committee was asked to make recommendations as early as possible regarding the appropriate agency to be responsible for developing the land and the subsequent estate management, and this is, of course, the crux of the Manchester request for compulsory powers to buy land for the creation of satellite communities. The Reith Committee agrees that the Government should have full powers for compulsory purchase on behalf of the agencies appointed to hold and develop them, and recommends that the site acquired should include the whole of the land within the proposed built-up area and a surrounding belt of appropriate depth averaging about three quarters of a mile. It recognizes that there is a minimum size for a new town below which it ceases to be a practical proposition as a balanced industrial unit, and that there is also an upper limit beyond which the appropriate balance between industry and housing is hard to maintain, internal distances are too great, open country too remote from the centre and the sense of corporate living and responsibility is lost.

Its preliminary study leads the Reith Committee to suggest in general, but subject to exceptions either way, a range of 20,000–60,000 population in the built-up area, a limit which for the reason already indicated is regarded by some as too small. The major interest of this first report, however, lies in the presentation of the problem, and the recommendations as to the type of agency to be adopted for development. Here the Committee recommends that each scheme for a new town should be treated separately, and the responsibility for both planning and development for each town should be entrusted to a single agency which should have no other responsibilities. In its opinion, a government-sponsored public corporation financed by the Exchequer is, in general, the most suitable agency, but a similar public corporation sponsored and financed by interested local authorities may sometimes be appropriate, or an authorized association. Other commercial enterprise or housing associations are rejected as inappropriate.

The Committee advances some suggestions regarding the constitution, powers and relationships of the proposed corporation and recommends that the freehold or feu should be held by a public body if the agency is not a public corporation, and that a central advisory commission should be established to provide a central pool of information and experience, and to advise the Minister of Town and Country Planning and the Secretary of State for Scotland and the individual agencies. Again, it is urged that the national policy for the location of industry must keep in step with the national policy for the development of new towns. Industrial trading estates, wisely sited, need to be established at the outset, and every encouragement should be offered to industrialists to favour these new centres. Yet again the necessity of further legislation is emphasized, for while the report passes over the question of betterment and compensation, it regards legislation to enable the Government to acquire a complete town-site, including green belt land, for transfer to a public corporation as a matter

of urgency in view of the speed at which housing estates are to-day being selected and developed, often with little regard to the broader social and economic considerations. Many local authorities are still handling the matter solely as a question of housing their own populations, and if this is allowed to continue and adequate powers are not provided for the creation of balanced new towns or satisfactory large-scale extensions of small towns under the indispensable unity of control, policy for the accommodation of overspill population will be hopelessly prejudiced by the loss of green belts and the distending of existing towns by unregulated sprawl.

The second interim report of the New Towns Committee is concerned with the further factors which have to be considered in advance of legislation, and emphasizes that it is essential for the success of new town projects that adequate finance shall be available at times when the opportunities for attracting people and industries are promising, and that it shall be available on favourable terms. This is one great lesson to be learnt from experience at Welwyn and Letchworth, as Mr. Osborn emphasizes; and while some points in relation to the provision of industrial and business facilities are left for discussion in the Committee's final report, the two interim reports show an outstanding sense of practical tasks. Points which legislation must cover to ensure that the proposed new towns are to become both going concerns and true communities are detailed, and the powers and policies of the agencies required for building new towns in the acquisition of land, ownership of sites, direction and control of development, finance and administration are lucidly set forth. The crucial processes of attracting and settling both inhabitants and industries, and the provision of basic public services, are dealt with; the magnitude of the problem, speed of construction and costs are discussed in relation to the national tasks of reconstruction in passages which deserve careful study. In the national housing programme the Committee believes that at least one in ten of the new houses during the next ten years should be in a new town or an extension of a small one. The building of new towns should be considered as part of the national rehousing and rebuilding programme that will in any event occur, and the real task is to allocate in the most efficient and socially useful manner resources which must inevitably be invested in this field in one way or another.

While the Reith Committee does not exclude absolutely alternatives to the State-appointed corporation as instruments for the planning and development of new towns, Mr. Silkin has rejected in his Bill all agencies save the public corporation. Apart from this criticism and the somewhat rigid limits set for population, the purposes of the Bill and most of its methods have been widely applauded. A plea has been made for generous compensation of landowners and others whose property may be acquired when work on the new towns begins. The 1939 basis of compensation is outdated and unfair, and the financial arrangements are admittedly imperfect; but the Bill, like the Reith Reports, does not sufficiently recognize the plain fact that to-day the large county boroughs are the only bodies able and willing to meet the immediate need for large-scale housing, and the satellite town is often the only available alternative to an immediate resumption of suburban fringe development. To ignore the experience of Manchester in building Wyttenshawe, for example, and the services of able and experienced officers of many kinds at the disposal of similar corporations and anxious to devote their energy and imagination to the rapid execution of such enterprises, would be indeed to resolve the conflict between counties and county boroughs by the Government assuming responsibility for the building of new towns, but at the cost of further delay. Nor will that step of itself provide the houses and towns required, unless the Government matches the enterprise Mr. Silkin has shown in appointing the Reith Committee and acting promptly on its recommendations by similar dispatch in the production of the long overdue general measure for compensation and betterment arising out of land control. It is indeed no disparagement of the work of the Reith Committee to point out that, as Mr. Osborn reiterates in his book, the planning and development of 'green belt cities' or new towns lead us straight back to the recommendations of the Barlow, the Scott and the Uthwatt Reports and the lack of decisions on problems which have confronted the Government of Great Britain for some six years. In regard to the development of new towns, the safeguarding of existing towns such as Oxford, and the preservation of amenities and the reconstruction of the special areas, a wealth of information and experience and ability already lie at our hand to use. The prime need is not so much for further inquiry but for decision, and for the enactment of the legislation which will permit the orderly execution of ideas and of principles on which there has now come to be so much general agreement, during the interval of fifty years since they were first expounded by Sir Ebenezer Howard and other pioneers.

TASTE AND SMELL

The Chemical Senses

By R. W. Moncrieff. Pp. vii + 424. (London: Leonard Hill, Ltd., 1944.) 25*s*.

In four hundred pages, Mr. Moncrieff has collected together most of the factual knowledge related to the sensations of taste and smell, and, for good measure, has summarized the many theories which have, from time to time, been advanced to account for these and their related phenomena. That such a volume must savour of 'compilation' is inevitable; and to say from a single reading of this book, packed as it is with data of all kinds, that it is difficult to obtain a clear view of the subject is no serious criticism of the author; indeed, he has been at pains to miss no single topic, and has chronicled everything from the cash value of ambergris to the nature of Raman spectra.

On the other hand, one feels that the author might well have taken to heart the advice given by that eminent monographer, Sherlock Holmes, who said,

"I consider that a man's brain originally is like a little empty attic . . . the skilful workman is very careful indeed what he takes into his brain attic. . . . It is of the highest importance, therefore, not to have useless facts elbowing out the useful ones." One wishes that Mr. Moncrieff had more actively exercised a critical faculty, and had given the ordinary reader a clearer indication as to which of the many theories discussed are really germane to a fundamental appreciation of the problems of osmic and gustatory sensation. He provides, as it were, an excellent *olla podrida*, but does not, like a good host, direct the attention of his guests to the more satisfying portions.

It has been clearly established, for example, that contact of odorous molecules with the olfactory hairs is a pre-requisite for the normal stimulation of the sensation of odour. These hairs exhibit a lipoid/aqueous emulsoid structure, and are the true *fons et origo* of the osmic disturbance; solution of the odorous substance in the lipoid or aqueous phase of these flagellæ is, therefore, the point from which all theories of osmic perception must proceed. There appear to be two main theories which offer an adequate picture of the processes involved: (1) a specific pharmacodynamic action; and (2) a physico-chemical disturbance of biochemical equilibria. If a specific pharmacodynamic action is postulated, the cell must translate intramolecular vibrations into specific nervous impulses; if the second explanation be adopted, means must be found to account for the high degree of specificity of the odours of individual chemical structures, in terms of a limited number of intrinsic factors.

The critical consideration is, therefore, the nature of the impulse which passes through the nerve fibril to the first cranial nerve, and thence to the olfactory bulb of the brain. It may be a single electrical trace analogous in characteristics to that depicted in text-books of sound as derived from, say, $B\flat$ on the oboe; if so, the olfactory cell must be regarded as a system capable of resonating with certain frequencies of the exciting molecule, and of commuting the resonance effect to electrical pressure impulses. In this way a molecule having several osmic frequencies would generate an impulse which would be a Fourier integration of such frequencies. This, in turn, implies the existence of a 'biopiezo-electric' effect, the precise nature of which has yet to be demonstrated.

If odour sensation is to be interpreted in terms of a physico-chemical interference with a set of equilibria, a number of steady impulses may be generated which, being conveyed separately to different parts of the olfactory bulb, produce their effect by the secretion of some specific substance analogous to, possibly, acetylcholine. The nerve terminals in contact with the substance of the olfactory cell act, therefore, rather in the same way as electrodes which are in equilibrium with the normal protoplasm of the cells, and only generate impulses when the cell substance is disturbed by the solution of a foreign substance. Ability to differentiate between a vast number of specific odours will depend either on a large number of different cells responding to different odours, or on a few (three to five) different cell types, the impulses from which are quantitatively interpreted and integrated by the olfactory bulb.

In the department of taste, Mr. Moncrieff has done a good service by collecting together almost all the data on this interesting, but diffuse, subject. The faith which he places in the older interpretations of the electrical experiments of Allen and Weinberg is not, in my opinion, justified. It would be ungracious, in view of the excellent work which Mr. Moncrieff has carried out in bringing together so adequately the scattered materials of these subjects, to cavil at small errors or aberrations resulting from war-time production and proof-reading, but the indiscriminate use of 'perylla' and 'perilla' on the same page, the continual use of 'bi' and 'di', in 'biacetyl' and 'disulphide', are irritating, as also is the consistent use of $=\mathrm{N}\equiv$ for nitrogen (p. 272) in its higher valency.

Finally, it is worthy of note that Mr. Moncrieff's volume is the only existing summary in the English language which covers fully the subject of its title, and it may be recommended confidently to those seeking a survey of the field. G. M. DYSON

TECHNIQUE OF ELECTROPHORESIS

Electrophoresis by the Moving Boundary Method

A Theoretical and Experimental Study. By Harry Svensson. (*Arkiv för Kemi, Mineralogi och Geologi, K. Svenska Vetenskapsakademien,* 22A, No. 10.) Pp. 156. (Stockholm: Almquist and Wiksells Boktryckeri A.B., 1946.)

THE Tiselius electrophoresis apparatus is now established as an essential part of the equipment of protein chemists and others interested in colloidal electrolytes. Its first appearance in almost its present form, in 1937, was the result of a careful technical study aiming at rapid separation without the thermal convection which caused trouble in earlier apparatus. This problem was so successfully solved that the detailed electrophoretic analysis of protein mixtures became a simple routine.

Soon, however, it became evident that concentrations and mobilities determined by such analyses were sometimes more apparent than real. In particular, there often seemed to be a component with low or zero mobility present in appreciable concentration, but corresponding to no known component of the mixture. The concentration of this apparent component was often different in the two limbs of the U-tube, providing clear evidence of some unsymmetrical error. Examination of fundamental assumptions provided the explanation along lines which were already familiar in the earlier work on mobilities of simple ions. For example, a stationary boundary is to be expected whenever two or more ionic species are present on both sides of the initial boundary. Although the general principles are now clear, their application to the mixtures of colloidal electrolytes and buffers which are of interest involves some awkward mathematics and has stimulated a search for simple treatments which enable the main phenomena to be clearly represented. The monograph now under notice is by Svensson, a pupil of Tiselius, who reviews the extensive literature on the above errors, and includes some original contributions which help to clarify the subject.

The observations needed for mobility and concentration determinations are now almost universally made by means of the gradients of refractive index at the boundaries between different layers of solution. The detailed behaviour of light in passing through such boundaries has been known for some time, and several methods of observing it have been used. The most convenient methods for routine purposes give

automatic graphs of refractive index gradient against distance through the boundary. A detailed study of the optical errors in these self-plotting methods has long been wanted, and is now provided, for one of them, in Svensson's monograph. The treatment is based on considerations of diffraction, but it does not attempt to go right back to Maxwell's equations. Instead, it assumes that the diffraction encountered is analogous to one of the familiar types, and thence deduces expressions for resolving power, etc. This procedure seems, on the face of it, to be more 'practical' than convincing, and a more fundamental attack, if at all possible, seems desirable.

The rest of the monograph contains a description of the latest Tiselius–Svensson apparatus, and some new and extensive experimental data chiefly concerned with the effects of various buffer ions on analyses of synthetic mixtures and of normal sera. These data demonstrate that, with the precautions recommended theoretically, the analytical errors can in fact be made small. This is very reassuring and will add much to the value of electrophoresis as a standard analytical technique.

J. St. L. Philpot

BEE-KEEPING

Plants and Bee-keeping

An Account of those Plants, Wild and Cultivated, of Value to the Hive Bee, and for Honey Production in the British Isles. By Dr. F. N. Howes. Pp. 224 + 32 plates. (London: Faber and Faber, Ltd., 1946.) 12*s*. 6*d*. net.

Honeybees and their Management

By Dr. Stanley B. Whitehead. Pp. 153 + 48 plates. (London: Faber and Faber, Ltd., 1946.) 12*s*. 6*d*. net.

THESE two books for bee-keepers are well presented, written in an agreeable style and furnished with many new and attractive illustrations, hard to come by in war-time.

Dr. Howes is a practical botanist, a member of the staff at the Royal Botanic Gardens, Kew, where he has had exceptional opportunities of observing the use made by bees of many plants, both common and uncommon, under conditions there applying. He has a double qualification, for he also understands bee-keeping; and in writing about plants in bee-keeping, his scientific training has enabled him to show wise discrimination in the selection and presentation of evidence derived from a very mixed bag.

His book is one for which bee-keepers have long waited, as there has been much confusion and superficial observation in the past for lack of sound botanical knowledge. Bee-keepers who have been advocating the wider planting of flowering trees, ornamental shrubs, herbs and other plants to increase the honey harvest now have available the correct botanical names not only of the species but also important information about the varying merits of particular recognized varieties.

The opening section deals with plants from the point of view of the bee-keeper; it covers nectar secretion, the problem of quality, pollen (all-important for bee-breeding), pollination (important for securing good and abundant fruit and seed), the growing of bee plants and some useful notes on hedges and wind-breaks.

The second section deals in great detail with some thirteen principal sources of honey in Great Britain. It is interesting to note the presence in this list of the blackberry, a plant often undervalued, for it has a long flowering period and is a reliable source from year to year owing to its deep-rooting habit. The titles of ling and bell heather on Plate 10 have been interchanged; this is possibly the only real mistake in the book, and is scarcely likely to be repeated as in the classical example of the exchange of titles in the illustrations of the hind legs of the queen and drone, an error which found its way undetected by the authors into two important works on natural history.

The last and longest section deals with a large number of sources of nectar and pollen having utility, especially where grown in considerable quantity. There are to be found in this section references to several sources not previously recorded, an important contribution to which Dr. Howes has modestly given insufficient emphasis. One would like to see these plants treated separately and decked with illustrations, as the botanical descriptions do not convey much to the average bee-keeper.

The controversy about the quality of honey from privet should be settled. Dr. Howes quotes the current view that the honey is objectionable. On the other hand, some claim to have taken considerable quantities and find it of good colour and flavour. I have taken enough to scent the air strongly around the hives for days together, and have experienced a bitter flavour which, however, disappeared in a few months. I cannot say for certain that the bitterness was definitely due to the privet content.

Dr. Whitehead's book is of a different character; for it is one of the many instructional books on bee-keeping. The author has set out to avoid the errors of tradition and lore, and has successfully avoided many which are in currency. In what he presents, however, he has relied too much on his limited personal experience, which is the more surprising as in an annotated bibliography he shows a nice appreciation of the merits and utility of the more important recent works. The advice given on important matters involving methods of management is not that usually given by teachers of wide experience and high reputation; moreover, the instructions given for important manipulations are inadequate to secure success.

In details there are a number of errors, some of which are mentioned below. The acid part of the bees' venom is not formic acid. Figures relating to the water content of honey require revision, especially in relation to fermentation, also the egg-laying of queens in Great Britain, the temperature for feeding syrup, the spacing of wires in the queen excluder, the depth of the Langstroth shallow frame and the sweetening power of honey (lactose in particular rating much above sucrose). Fortunately, under good management, a stock of bees does not raise queen cells annually. A nucleus should not be sent by train with a queen cell in it, and one sold should have a queen laying properly. Bees actually prefer water containing a little salt, and the addition of 1 part in 1,000 helps to keep down the growth of algæ. The National hive is in fact widely and successfully used for the production of sections. For heather work it is advisable to use a rack taking only twenty-four so as to allow some extra side protection, or hanging frames can be used.

Subject to some careful revision of detail, this book should prove a useful and attractive addition to the literature available.

E. B. Wedmore

SCIENCE IN EGYPT

By Prof. MAX BORN, F.R.S., and
L. J. F. BRIMBLE

FOLLOWING invitations to lecture in Cairo, the authors of this article had the opportunity to visit Egypt during two consecutive periods (February–March; March–April) and to see something of ancient and modern Egypt. We wish to give a short account of our experiences in regard to Egyptian science.

Cairo has the oldest institution in the world which deserves the name of a university, namely, El Azhar, founded in 972 A.D. (361 of the Hegira), a school of Mohammedan religion, law, history and literature which in pre-war times had about 17,000 students and at present has more than 12,000. In fact, Mohammedan students from all over the world attend this institution, which is the chief theological seminary of Islam. Teaching of the Qur'an (Koran) is its main object, and the full course lasts seventeen years. Parts of civil law, in particular everything concerned with family life, marriage, divorce, are still in the hands of courts based on this School, while the rest of juridical life is practised by courts of more modern origin and education, coming from the law school of Cairo's new University.

The new University was founded in 1925 by King Fouad I with the purpose of developing and teaching modern ideas and techniques. Fouad I University (as it was called after 1940) has at present eight faculties—arts, science, law, engineering, medicine, commerce, agriculture and veterinary medicine. Most of them are housed on a magnificent campus situated on the left bank of the Nile, in the suburb of Giza, on the road to the Pyramids, in a group of splendid modern buildings. Fig. 1 shows only a part of the central University area. The Great Auditorium with its magnificent rotunda is opposite the main gates. On the left is the Faculty of Law and (behind) some of the biological buildings. Chemistry and physics are behind that again. On the right is the library. At some distance off to the left are the Faculties of Agriculture and Engineering. There will be scarcely any European university which can compete in lay-out and architectural beauty with this campus. The Egyptians had the advantage of the past experiences of most other universities, and they have not lost this unique opportunity. What we have seen of the lecture rooms and laboratories, the Great Auditorium (Fig. 2) and the administration quarters, is well designed and in excellent taste. Behind the campus stretches a wide area for sport and physical exercise, with large stadia, swimming pools and other buildings, all in the same grand manner. The Faculty of Medicine is situated on Roda Island (where according to tradition the babe Moses was discovered), and at Kasr el Ani.

Buildings for mathematics, chemistry, etc., are completed and those of other sciences are planned or in construction. The Departments are to-day provisionally crammed partly (junior classes) into the existing buildings, partly (advanced classes and research) still at the original site of the University, at El Zafaran Palace in Abbassia—a northern suburb of Cairo. This partition is most inconvenient as the distance between Giza and Abbassia is more than six miles. It is hoped, however, that the whole Faculty of Science will have settled at Giza by 1950.

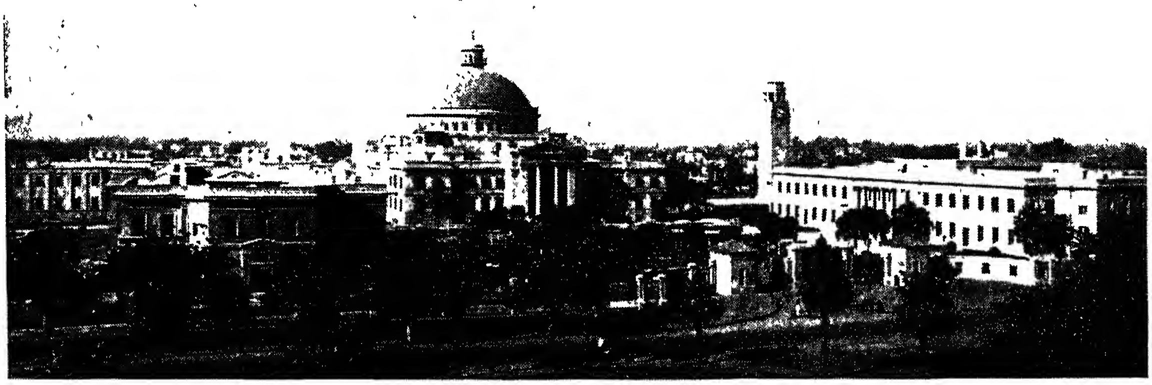

Fig. 1. General view of part of the new University campus. In the centre is the Great Hall with its impressive rotunda; to the right are the library and clock tower; to the left is the Faculty of Law with part of the biological buildings behind. There are many other buildings (mainly science) behind the Great Hall. The Faculties of Agriculture and Engineering are off the picture to the left

The rector of the University is Ali Ibrahim Pasha, the well-known surgeon. The present dean of the Faculty of Science is Prof. A. M. Mosharrafa Pasha, professor of applied mathematics. His publications are mostly concerned with problems of relativity, but he is interested in all branches of theoretical physics. Mosharrafa is a brilliant administrator and organiser; and he, together with former deans of the Faculty of Science and of other faculties, have, under the eminently wise guidance of Ali Ibrahim Pasha, been responsible for the developments which have led to the establishment and growth of this University. The head of the Department of Pure Mathematics is Prof. M. Mursi Ahmad, trained at

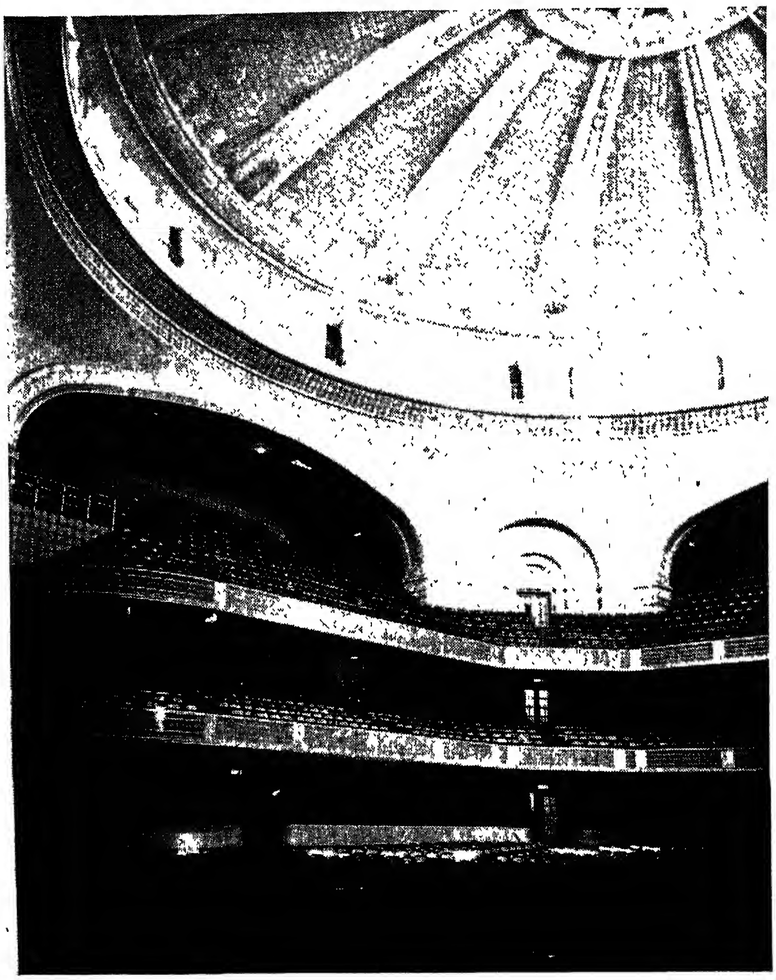

Fig. 2. INTERIOR OF THE GREAT HALL

burgh (prolonged action on mice, low toxicity) and partly with Prof. Ahmed Ghonein, Faculty of Agriculture, Cairo. A remarkable result of this work may be mentioned. Hens receiving 'stilbene' began to lay eggs more than one month earlier than the control group. Former professors of chemistry have been Dr. E. C. Grey, Dr. D. H. Bangham (also dean of the Faculty) who is now attached to the British Coal Utilisation Research Association, and Dr. Ahmed Zaki Bey.

The Government has an astronomical observatory near Helwan, some twenty miles south of Cairo, situated on the fringe of the Eastern Desert, overlooking the wide valley of the Nile.

The climate of Egypt is most favourable for astronomical work, and it is no wonder that the director, Dr. M. R. Madwar (delegated as professor of astronomy in the University), is planning considerable enlargement and more powerful instruments. The teaching of the students in astronomy is in the hands of Dr. Abdel Rhaman, who worked for some time in Edinburgh.

Another Government institution is the Physical Department of the Ministry of Public Works, under the directorship of Dr. H. E. Hurst. Its main activities are meteorology and research on the Nile. But apart from that, Hurst's laboratories have done most useful service to the country, and also to the British Army during the War, by constructing and producing all kinds of scientific instruments which could not be supplied from Europe. In fact, part of the buildings look still more like factories than laboratories. The meteorological service works on the usual lines; under the special conditions of Egypt, however, forecasts seem to be easier and more reliable than in many other parts of the world. Apart from the Delta, there is scarcely any rain along the Nile valley, and 'bad weather' means the Chamsin, the hot desert wind loaded with dust. (However, one of us has experienced two heavy thunderstorms with torrential rains during a two months' stay.) The control of the water of the Nile is the result of more than forty years study and research and is one of the outstanding results of science in Egypt. An explanation of the regulation of the Nile, with its barrages, reservoirs, irrigation and drainage canals, would exceed the space of this article. The administration of this enormous system, which produces three or even four crops a year, is an admirable organisation. Each single fellah (Egyptian peasant) has definite hours allocated to draw water into his field from the irrigation ditch. All this depends on the exact forecast of the water available at a given time, and this again on the knowledge of the flux in all parts of the river, from the Blue and the White Nile down to the last canal. Exact measurements of the current over the whole area of the river and the canals are therefore neces-

Whittaker's School in Edinburgh. Dr. E. L. Ince was formerly the professor of that Department. As one of us had the opportunity of acting as external examiner for the advanced class of one of these Departments, we can compare its standard with British schools; the result is that it is very high and of the same level as Edinburgh. It might be pointed out incidentally that the external examiners for all final examinations and higher degrees in the Faculty of Science are men of science outside Egypt altogether—mainly professors in British universities. These examiners are asked to maintain a standard for Cairo equal to that of their own universities.

Prof. T. L. R. Ayres is director of the physical laboratories, where a great number of students are taught and research work on supersonics is done. There is also a physics department attached to the Faculty of Engineering under Dr. A. Waly, who was trained in Germany and is mainly interested in nuclear physics.

Chemistry under Prof. A. Schoenberg (whose communications in *Nature* have been spread over a long period) is a very big Department with a wide research programme, concerning photochemical reactions in sunlight, the synthesis of substances with sex-hormone properties (non-steroid œstrogens) and their applications. The latter are worked out in collaboration partly with Dr. J. M. Robson in Edin-

sary, and the State Laboratories construct and produce the instruments used for this purpose. The velocity is measured by a kind of small turbine, and as the flow in many canals is very slow the sensitivity of these indicators must be correspondingly high. The Department is also concerned with future improvements of the system, such as the planned drainage of the Sud region in the Sudan, where at present a great proportion of the Nile water is lost by evaporation in swamps; the plan for a barrage at the mouth of Lake Albert, etc. Blocking of the channels of the White Nile, together with the transpiration of the swamp vegetation, is responsible for a loss of about 70 per cent of the water between the great lakes and Malakal. An expedition was sent from the Botany Department of the University this year to study the problem; another will be sent next year.

Another big scheme already in construction is a new dam near Aswan for producing hydro-electric power. The chief engineer for this project is Abdul Aziz Achmed Bey. The main purpose of this is the manufacture of artificial manure to replace the natural silt deposits which under the present system of perennial agriculture are lost in the reservoirs.

Agriculture is, of course, the main industry of the country, and much is done to improve it. There are Government departments for research, a Royal Agricultural Society with an Exhibition Ground on Gezira Island, and an excellent Agricultural Museum. It consists of several attractive buildings in lovely gardens on the left bank of the Nile, north of Giza. One of these contains historical collections, everything found in tombs and temples of ancient Egypt which is concerned with agriculture. There are reliefs showing all types of farming, of animals and plants down to the times when the Pyramids were built; mummies of wild and domesticated animals; and seeds of numerous plants found in the tombs. Within the grounds of the Royal Agricultural Society there is also a separate Cotton Museum. Both these museums are splendid examples of up-to-date methods in visual education.

The other buildings contain representations of modern farming in lively models, pictures and graphs. It was pleasant to see crowds of simple folk, obviously peasants in their best, thronging these rooms and halls, deeply interested in the methods demonstrated by the exhibitions. In fact, life and work of the Egyptian fellah is still primitive and hard; much has to be done to raise his standard of living. But a beginning is being made.

Though most of the new buildings at Giza designed to house the Departments of Mathematics, Chemistry and Geology were completed by 1939, it was not until 1942 that a building was adapted for the Department of Botany and Zoology. Teaching, and even part of the research, therefore, is still divided between the old buildings at Abbassia and the new ones at Giza. The Faculty of Science was also necessarily partially disturbed by the Army authorities during the War. In spite of this, the biological departments are large, with many demonstrators who are themselves reading for M.Sc. degrees. A considerable number of M.Sc. and Ph.D. degrees are awarded each year for research.

The Botany Department has two professors—Prof. F. J. Lewis (who has just resigned his chair) and Prof. Y. S. Sabet. Under them is a staff of very active lecturers and demonstrators carrying on research in plant physiology, morphology, taxonomy, elocogy and mycology. Reference has already been made to some of the botanical field work. Previous professors of botany have been Dr. Gunnar Tackholm, who, together with his wife, was compiling a comprehensive flora of Egypt (Mrs. Tackholm is continuing this work, see *Nature* of May 11, p. 635), Dr. F. W. Oliver and Dr. F. E. Weiss (the last-named only temporarily).

The Department of Zoology devotes much attention to experimental zoology, though work on animal morphology, anatomy and taxonomy is also being done. The results of some of this work is now appearing in *Nature* in the correspondence columns. The present director of the Zoology Department is Prof. K. Mansour. Former professors were Dr. V. Jollos and Dr. A. Naef (the last-named still enjoying the status of visiting professor of zoology (comparative anatomy)).

Entomology is a small department so far as number of students is concerned, but not as regards activity, for the well-known Prof. H. C. Efflatoun Bey is in charge. Efflatoun Bey has done invaluable work on the insects of Egypt and published mainly in the *Proceedings of the Royal Entomological Society of Egypt* (see *Nature* of July 6, p. 35). This scientific society is one of Egypt's most active, with a magnificent building, housing museum, lecture theatre, research rooms, etc., in the centre of Cairo. The Entomological Department of the University and the Royal Entomological Society have also collaborated with expeditions abroad dealing with locust problems.

Geology is under the direction of Prof. O. Zdansky. A former professor was Dr. I. Hoegborn, who was also dean of the Faculty for two years.

Outside the Faculty of Science, there are other University scientific activities. For example, there is a large Faculty of Agriculture and Horticulture at Giza. This has departments of botany, entomology, agriculture and agricultural engineering. The large Department of Horticulture has extensive experimental and ornamental gardens. There are well-equipped laboratories for plant food products where problems of food preservation, canning and dehydration are being attacked. Research is also being carried out on the vitamin content of fruit and vegetables. Valuable work is also being done on the silk worm.

Then there is the Cotton Research Board, which also has its well-equipped laboratories, under the direction of Dr. W. Lawrence Balls, housed at Giza (see *Nature* of July 6, p. 9). Here for more than twenty-five years research has been conducted on the breeding, growing and physiology of the cotton plant, and the economic uses of different varieties of cotton, the quality and treatment of the fibre. This is the centre of the cotton industry in Egypt, and the successful development of the industry is due entirely to the work carried on in these laboratories.

Much work of scientific value is also being carried out in the Faculties of Engineering and of Medicine; but time would not allow either of us to visit these centres of teaching and research.

The museums in Cairo have attained a particularly high standard. The Cotton Museum and the Museum of the Ministry of Agriculture have already been mentioned. In these, great ingenuity has been shown in devising methods (mainly electrical) for driving home important points. Those interested in visual education should not miss these institutions if visiting Cairo. Then there is, of course, the world-famous Cairo Museum containing many important antiquities

including those of Tutankhamun. What we did miss, however, were a natural history museum and a general science museum corresponding respectively to the British Museum (Natural History) and the Science Museum (dealing mainly with engineering achievements) respectively. The Egyptian authorities have already shown special ingenuity in the organisation of their museums, so we hope they will extend their valuable work to include these others.

Science is certainly developing seriously and quickly in Egypt. Only those places visited by us have been briefly described here, but we hope it is enough to indicate that the academic and government authorities in Egypt are showing a deep appreciation of the value of science. An Egyptian Academy of Sciences is now flourishing and will soon begin its own publications. This was described by Mosharrafa Pasha in *Nature* of May 4, p. 573. The Faculty of Science is also publishing a general scientific journal which, we hope, will achieve national proportions in due course.

The Farouk University at Alexandria has yet to get into its stride; but we have little doubt that there too, in due course, will be developed another modern centre of science and culture.

We should both like to take this opportunity of thanking our Egyptian colleagues for their friendliness and the kind hospitality with which they received us.

SUPERSONIC CRIES OF BATS

By Dr. DONALD R. GRIFFIN
Harvard University

THE recent discussion of bats in *Nature*[1,2] raises certain questions which I believe can be answered on the basis of new data resulting from a continuation of the investigations in which Dr. Robert Galambos and I were engaged before the War[3,4]. The bat's ability to avoid obstacles depends upon a method of perception which I have called 'echo-location', or the location of objects by means of echoes[5]. The bats which we studied emit for this purpose short pulses of sound and hear the echoes which return from any solid object in their path. The emitted sound has a frequency of approximately 50 kilocycles per second, and hence is virtually inaudible to human ears. Many blind men also seem to use some form of echo-location based on audible sounds, for they can often detect obstacles at a distance, but lose this ability if their ears are stopped, or if they are distracted by loud noises[6]. Radar and the various underwater acoustic devices which locate distant objects by means of echoes are also examples of the general process of echo-location.

It is unfortunate that so few biologists have had access to the instruments needed to detect and study high-frequency sounds. The Noyes–Pierce sonic amplifier which we used during 1938–41 is described in the literature[7], but it has not been produced commercially. Recently I have been using a combination of commercially available instruments consisting of a condenser microphone (Western Electric 640*A*) followed by a cathode follower stage and several stages of voltage amplification until the sound waves emitted by the bat can be reproduced on the face of a cathode ray oscillograph. The apparatus was in part purchased with the aid of a grant from the Elisabeth Thompson Science Fund, and in part loaned by the Psycho-acoustic Laboratory of Harvard University. I hope that similar apparatus will be used by others interested in the sounds produced by bats.

Since Prof. Hartridge was the first to suggest that bats might guide their flight by means of high-frequency sounds, it is gratifying to find that he is again taking an active interest in the problem. It is to be regretted, however, that his stimulating theoretical analyses could not have been accompanied by first-hand experience with bats in the laboratory, for I feel that this would have modified some of his conclusions. For example, the description of the sounds produced by bats is needlessly complex because the supersonic pulse, the faint audible click and the audible buzz are considered as three distinct entities, for each of which a separate source must be postulated. As pointed out in our 1942 paper[4], the supersonic pulse and the click always occur simultaneously, the buzz being merely the rapid repetition of the click at rates as high as sixty per second. The audibility of these pulses of sound varies somewhat depending upon the condition of the bat, and it probably varies from species to species. Dijkgraaf[8] discovered the process of echo-location independently without the aid of any apparatus by hearing bats emitting what he describes as a rattling sound whenever they were orienting themselves, either in flight, when crawling or when at rest. He used three species of bats, rather closely related to those we studied (*Myotis daubentonii*, *M. emarginatus* and *Pipistrellus pipistrellus*); and it seems likely that his "rattling sound" is what we described as the buzz.

Thus the bat emits for purposes of echo-location a bundle of sound waves which is capable of stimulating both the human ear (maximum sensitivity at about 3 kc. and upper limit about 20 kc.) and also a physical detector (the Noyes–Pierce apparatus) which is sharply tuned to 50 kc. While the audible click and buzz are faint sounds, the supersonic pulse is relatively intense (roughly 10–50 dynes/cm.^{2} at the bat's mouth).

A modulated supersonic sound is not ordinarily audible even though the frequency of modulation lies within the range of the human ear, so that two possibilities suggest themselves to account for the bat's audible click: (1) Part of the bat's cry might consist of 50 kc. waves and the remainder of waves in the audible range. This would involve a change in frequency during the pulse from 50 kc. to some frequency below 20 kc. (2) Since the bat's pulse is of short duration, a Fourier analysis would reveal that energy was scattered to both higher and lower frequencies. Thus the abrupt starting and stopping of the bat's supersonic cry might stimulate our ears even though a steady sound of 50 kc. is inaudible. In addition to the transients introduced by the brevity of the pulse, one should also consider in this connexion the non-linearity of the human ear at high intensities[9], which would tend to rectify the brief burst of supersonic sound into a single low-frequency wave. The second alternative is attractive, because it does not require a separate mechanism to produce the audible click.

To decide between these alternatives it is necessary to have an accurate picture of the actual sound waves present in the bat's pulse, and I have recently obtained such pictures by photographing the record of the bat's cry obtained on a cathode ray oscillograph. This work is still in a preliminary stage; but in view of the discussion in *Nature* it seems worth while to reproduce here four typical pictures of the pulses used by

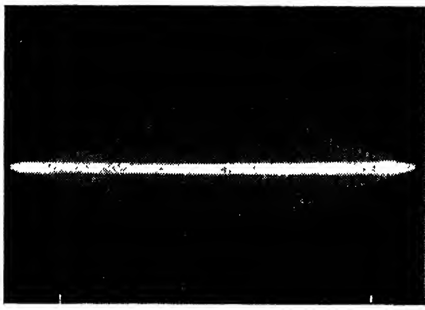

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Fig. 1.

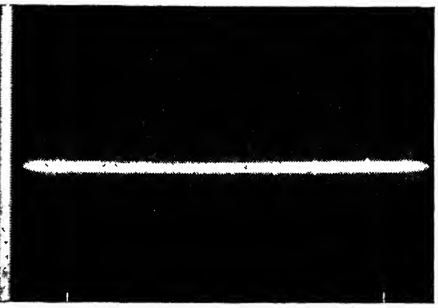

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Fig. 2.

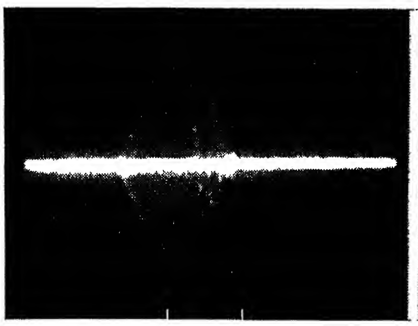

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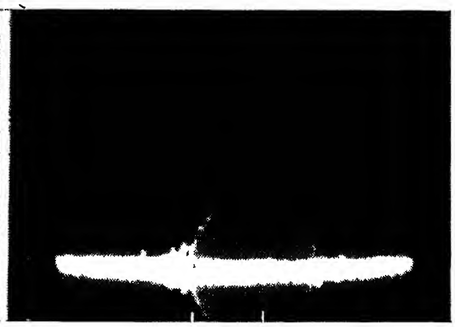
Fig. 3.



0·001 sec.
Fig. 4.

Figs. 1—4. CATHODE RAY OSCILLOGRAPH RECORDS OF THE SUPERSONIC CRIES OF BATS. HORIZONTAL SWEEP FREQUENCY 200 C.P.S., EXPOSURE 1/16 SEC., HORIZONTAL AMPLIFICATION VARIED TO GIVE THE VARIOUS TIME AXES SHOWN; SWEEP MOTION FROM LEFT TO RIGHT

Myotis l. lucifugus to echo-locate obstacles. The primary purpose of these records was to determine the duration of the pulse, and this will be discussed below; but the figures also show that the pulse consists only of waves well above 20 kc. This conclusion cannot be drawn solely from Figures 1, 2 and 3 because they were taken with a high-pass filter in the circuit which attenuated the low-frequency response of the microphone, but gave an essentially uniform response at frequencies from 30 to 70 kc. Such a filter is necessary for accurate reproduction of supersonic sounds because the response of the microphone decreases rapidly above 10 kc., and the filter compensates for this drop in sensitivity in the supersonic range.

However, when the filter was removed so that the audible frequencies were recorded faithfully, I obtained pictures such as Fig. 4, which still showed no traces of low-frequency waves. Under these conditions the system was almost equally sensitive from 30 to 10,000 c.p.s., but its sensitivity dropped steadily at higher frequencies. If two sounds of equal physical intensity were presented to the microphone, one at 5 kc. and the other at 50 kc., the cathode ray deflexions for the former would have had 30 times the amplitude of the latter. Fig. 4 would have revealed any low-frequency waves giving more than 1/20 the cathode ray deflexion of the supersonic pulse; since none is visible, we may conclude that any such low-frequency sound waves in the bat's cry had less than $1/30 \times 1/20$ or 1/600 of the amplitude of the supersonic waves.

Furthermore, whispered sounds which had approximately the same loudness as the bat's audible click gave cathode ray deflexions which were easily visible. Thus I am inclined to favour the second alternative mentioned above, namely, that the audible click results from the abrupt starting or stopping of the pulse. Here again Figs. 1–4 are illuminating, for they show that the pulse is of very short duration and that the envelope is rather abruptly cut off towards the end of the pulse. However, further analysis of the records will be necessary before these questions can be answered with assurance.

In view of the question raised by D. W. Ewer in the December 8, 1945, issue of *Nature*, it is interesting to note, in Figs. 1–4, the extreme brevity of the bat's pulse. Figs. 1 and 2 show the individual waves in two representative pulses, while Figs. 3 and 4 show the envelopes of two other pulses recorded with lower sweep speeds. Although the successive pulses of the same bat vary considerably in the form of the envelope, the bulk of the energy is almost always emitted within a period of one millisecond. In the pulse shown in Fig. 3, it can be seen that the waves rose above 1/25 of their maximum amplitude for only 1·6 millisecond, while even in Fig. 4, where the maximum deflexions went off the screen, the total recorded duration was only 2·3 milliseconds. These durations are considerably shorter than our previous estimates of "no more than 0·01 sec." might lead one to expect; but as pointed out in our 1942 paper[4], the mechanical recording system which we were then using was not capable of responding fast enough to measure accurately the duration of such brief pulses, and at that time we were able to give only a maximum figure.

Since the envelopes shown in Figs. 1–4 have sharp but not perpendicular cut-offs, the apparent duration will depend upon the sensitivity of the recording system; if only the waves which exceed 1/5 of the peak amplitude are above the baseline, the pulse will appear shorter than 1 millisecond. If on the other hand it were possible to record waves of so little as 1/100 of the peak amplitude, the pulses would appear longer than the 2·3 milliseconds measured from Fig. 4. In order to estimate accurately the minimum working distance at which the bat can echo-locate objects, it would be necessary to know the ratio between the intensity of the echo and that of the original pulse, for it is the duration of the pulse at or above the intensity of the returning echo which is important in this connexion. It seems clear, however, that pulses such as those shown in Figs. 1–4 should permit a bat to echo-locate objects as close as 1 ft., for the echo would require about 2 milliseconds to

travel this distance and return. At no time have I seen any evidence that the pulse duration varies with the rate of emission as Hartridge suggests.

Another factor which may well facilitate echo-location at close ranges is the progressive drop in frequency throughout the pulse. This can be seen clearly in Figs. 1 and 2, and it is not due to any artefact in the recording system, for the sound waves from a Pierce magnetostriction oscillator tuned to various frequencies up to 50 kc. showed no change across the tube face in the spacing between the peaks of the successive waves. Thus when overlap between pulse and echo occurs it will be the high-frequency beginning of the echo which overlaps the low-frequency end of the original pulse, so that there will be a considerable frequency difference which the bat may use to differentiate between the two sounds. In Fig. 2, the frequency of the first few waves is almost 80 kc., while at the end of the pulse it is below 50 kc.; this drop of somewhat less than an octave seems to be typical. There is no indication, however, that the end of a supersonic pulse ever drops into the frequency range of the human ear.

These supersonic pulses are emitted through the bat's mouth, as we felt we had amply demonstrated in our 1941 paper[3] by reporting that four out of five bats with their mouths covered failed to produce anything like their normal intensities of supersonic sound, and were therefore unable to avoid obstacles. The one exception, No. 37, did avoid obstacles and emit supersonic cries, although these were, as I recall, weaker than normal. We suggested that this sound may have escaped through the nostrils; but that it was also possible for the gag on this bat's mouth to have remained defective, despite our repeated efforts to make it secure. Other bats often scratched small holes through the collodion gags in the course of our experiments, and when this happened they would both emit supersonic sounds and avoid obstacles.

Hartridge argues, in *Nature* of October 27, that bats emit the supersonic pulses through the nose, and in discussing this hypothesis he states: "Bat No. 37 which they thought to be the exception was, in fact, the rule . . . a possible explanation is that they [the other four bats] had some nasal defect such as a cold in the head". I prefer not to rely on such an assumption, and since reading this article I have tried the obvious converse experiment of closing the nostrils of bats with collodion and other materials. Seven bats were used, four *Myotis l. lucifugus* and three *Eptesicus f. fuscus*. After the nostrils were plugged they all continued to make supersonic cries and avoided the walls and furniture successfully, so that I was convinced that their powers of echo-location were not seriously impaired.

These bats not only flew normally when their nostrils were plugged; but also they did not seem unduly eager to remove the plugs. This was in sharp contrast to the behaviour of deafened or gagged bats, which are very reluctant to fly and if left alone spend most of their time scratching at the material which covers their ears or mouth. It is interesting to note that when the bat's nostrils were plugged the audible clicks were considerably louder than normal to my ears. While the clicks became less audible after the bats had been flying for several minutes, they always seemed louder than when their nostrils were unobstructed. This indicates that the nasal cavities play a part in determining the wave-form of the pulse, just as they do in the human voice, but that they are not a primary factor.

Further evidence that the clicks issue from the mouth can be obtained by looking at the back of a live bat's mouth, as we pointed out in 1942. A lens is convenient, and a good light is essential. When the mouth is opened far enough one can see the junction between the epiglottis and the soft palate. In a resting bat, even when its mouth is held open in this way, the rim of the epiglottis is in contact with the posterior edge of the soft palate so that the bat breathes through its nose. This is probably also true of a bat with its mouth partly open, the usual condition during flight. When supersonic sounds are emitted, however, a very rapid motion separates the epiglottis and soft palate. Although one sees only a blurred image of this motion, it is clearly associated with the production of both audible and supersonic cries.

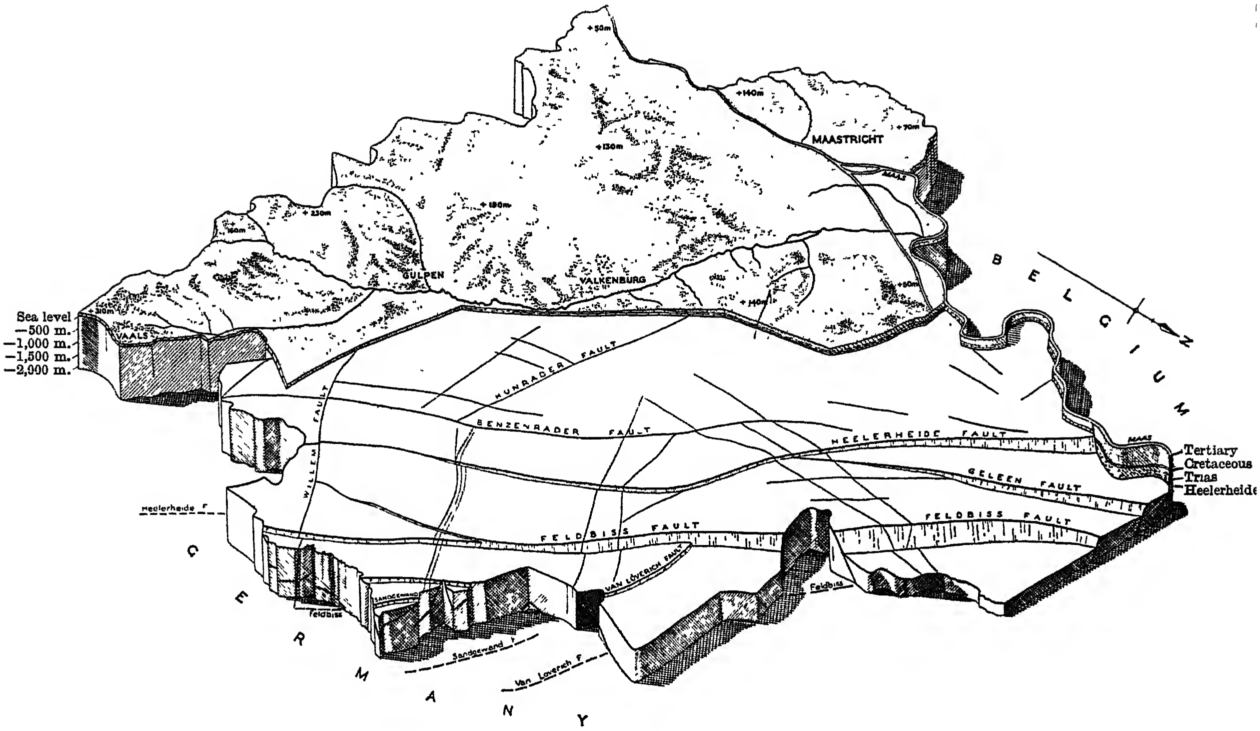
Further conclusions are not warranted until more records have been analysed, but in view of the recent discussion in *Nature* it seemed likely that these preliminary observations would be of interest.

[1] Hartridge, H., *Nature*, **156**, 490 (1945).
[2] Ewer, D. W., Hartridge, H., and others, *Nature*, **156**, 692 (1945).
[3] Griffin, D. R., and Galambos, R., *J. Exp. Zool.*, **86** (3), 481 (1941).
[4] Galambos, R., and Griffin, D. R., *J. Exp. Zool.*, **89** (3), 475 (1942).
[5] Griffin, D. R., *Science*, **100**, 589 (1944).
[6] Supa, M., Cotzin, M., and Dallenbach, K. M., *Amer. J. Psych.*, **57**, 133 (1944).
[7] Noyes, A., and Pierce, G. W., *J. Acoust. Soc. Amer.*, **9**, 205 (1938).
[8] Dijkgraaf, S., *Verslagen Ned. Akad. v. Wetensch., Afd. Natuurkunde*, **52** (9), 3 (1943).
[9] Stevens, S. S., and Davis, H., "Hearing", pp. 184–200 (John Wiley and Sons, New York, 1938).

GEOLOGICAL AND GEOPHYSICAL STUDIES DURING THE WAR ON BEHALF OF THE ASSOCIATED COLLIERIES OF THE NETHERLANDS

By Dr. L. U. de SITTER
University of Leyden

FOLLOWING the outbreak of war, visits by the advanced students of geology of Dutch universities to foreign countries in order to acquire the necessary field training in mountainous country, as was the practice in peace-time, were no longer possible. Moreover, a considerable number of young geologists just leaving the universities and the Delft Technical College, or on leave from abroad, were caught by the War and cut off from their field of activity. In order to ease this position, an organisation was created by the Associated Collieries of the Netherlands, in which association the Government collieries played a predominant part, to employ some forty of these young men in various fields of geological science, with the sole object of promoting, in the widest sense, scientific research for the collieries. The former Inspector General of the Mines, the well-known geologist, Mr. van Waterschoot van der Gracht, was the chief of this organisation until his death in August 1943, when he was succeeded by the present writer. The assistance of Prof. Jongmans, the distinguished phytopalæontologist and authority on carboniferous stratigraphy, director of the Geological Bureau of the South-Limburg Mining District, and of Dr. Tesch, director of the Department of the



Geological Survey responsible for the Geological Map of the Netherlands, helped the organisation from its inception.

Results of this work are being issued in a series of publications called the "Mededeelingen van de Geologische Stichting, Serie C", and will contain eventually some forty parts of which twenty-one have been published to date, while the rest are largely ready in manuscript. Some parts are published in English or French, and many have an English or French summary. The whole project, including publication costs, has been paid for by the Associated Collieries, except for the geophysical survey, which is undertaken by a temporary department of the Government collieries. The total cost of the whole survey, salaries, materials, publications, etc., will exceed 800,000 guilders (about £80,000). As perhaps only half the work can be regarded as having an immediate economic value for the collieries, one can only admire the munificent way in which the managements, in particular that of the Government collieries, responded to the situation.

The studies included an extensive gravimetric survey of the south-east of the Netherlands, palæontological studies of the Coal Measures, the Cretaceous and Tertiary, research work on tectonics, preparation of large-scale contour maps and tectonic maps of the coal district, stratigraphical studies of the Coal Measures, Cretaceous, Tertiary and Quaternary, studies in sedimentary petrology, mainly of the Quaternary and Tertiary strata, and certain miscellaneous studies. Attention is directed here to a few outstanding achievements.

The gravimetric survey succeeded in tracing, below the blanket of younger formations, the large faults which form the boundaries of the South Limburg Coal Field, as well as of the Peel area farther north, which will be exploited in the future, with an accuracy hitherto unattained by any other method. The South Limburg faults are shown on the accompanying block diagram; they run north-east—south-west. By spacing the stations only 50 metres apart, very detailed sections were run over the more important faults, which will undoubtedly save much costly underground exploration. New extensions of the coalfield were proved and former errors of the fault pattern were corrected. The assistance of the Shell Oil Company in particular has been of great value in these geophysical activities.

Palæontological work on large collections both of Foraminifera and molluscs from bore-holes into the Tertiary strata, which included bore-holes made by the Shell Oil Company in the northern provinces, will make the Dutch Tertiary perhaps the best investigated of Europe. In the Coal Measures an extensive survey of the spores reached some outstanding results, which together with petrological analyses of coal seams enabled a very trustworthy correlation of the coal seams to be made. Marine and freshwater faunas were thoroughly examined and correlated with those of neighbouring countries.

Tectonic research has been undertaken largely for technical purposes, and the set of tectonic 1:5,000 maps of the whole district, on which every coal seam of value and every known fault is recorded, irrespective of concession boundaries, will prove of great value for the future. From the contour map of the eroded surface of the Coal Measure the accompanying block diagram has been constructed. Very interesting results were obtained from observations on the joints and cleavage in the coal seams, and a new approach to the systematics of joints was made. The observations are mainly of technical value, but purely scientific results of great interest may also be expected.

The detailed stratigraphy of the Coal Measures, shown by isopachyte maps and many other data, gives an insight into the development of this sedimentary series, where the sluggish river courses, ever

changing their position in the swamps, regulated the alternation of sands, shales and peat.

The studies in sedimentary petrology of the younger Tertiary formations proved that only by this method can a trustworthy correlation of these continental formations be reached. In the Quaternary also it proved once more its value ; the alternating influences of Rhine and Meuse in the northern Limburg was clearly demonstrated ; older correlations of these sands and gravel beds had to be corrected ; and a much better insight into the Quaternary movements along the large faults of the whole district has been gained.

Although the Germans were aware of the presence of this large body of scientific workers and tried several times to transport them to Germany, we somehow succeeded by various methods in retaining the whole group intact until the liberation of southern Limburg by the Allied Armies. Several of them then joined the Army, and since then the organisation has been liquidated except for the Geophysical Survey, which suffered a severe loss because the Germans destroyed all the maps and sections already prepared. Fortunately, the fundamental data were preserved and we are well on our way to the final report.

By the joint effort of industry and science in a critical period, many young Dutchmen were saved from deportation, and by these efforts a large volume of scientific work has been accomplished.

OBITUARIES

Prof. T. H. Morgan, For.Mem.R.S.

Prof. Thomas Hunt Morgan, who died on December 4 at the age of seventy-seven years, played a leading part in establishing the science of genetics in an impregnable position. To few is given the opportunity to open such wide fields of research. Still fewer individuals have the capacity to seize the opportunity.

Morgan started as a zoologist on strictly morphological lines, but quickly saw the value of the experimental method for problems of development such as polarization of the frog's egg, and regeneration. Here he followed Roux and Driesch, and in his two early books "Evolution and Adaptation" and "Experimental Zoology", he foresaw the great advantages of experimentation in zoology. In later years "Experimental Embryology" (1929) returned to the same theme, making use of the greatly increased knowledge acquired as the result of experiments.

Morgan possessed two outstanding characteristics : his ability to choose the right men to help him and his ability to change his views as the facts required. Prior to 1900, he was distrustful of the theory of natural selection, and on the publication of De Vries' "Mutations Theory" turned to it to account for the origin of species. Not content with theorizing, he took up the breeding of *Drosophila*, which had been shown by Lutz, Payne and others to be amenable to culture in the laboratory. He was expecting to find a repetition of the phenomena shown by *Œnothera*, but soon discovered that *Drosophila* did not give rise to new species. Instead it provided valuable material for the study of segregation.

From 1909 onwards, Morgan attracted and encouraged a brilliant group of workers, many of whom were trained under Wilson and followed their individual lines of attack on the problems of inheritance in *Drosophila*. As a result of the combined efforts of Morgan's team, *Drosophila* became the organism best known genetically, and the facts of linkage and crossing-over and their relationship to chromosomes became firmly established. As the results accumulated, Morgan was driven to accept the theory of natural selection which he had rejected earlier ; thereby he demonstrated the ability to alter his views to accord with the evidence.

T. H. Morgan received many honours, among which may be mentioned the award of a Nobel Prize for Medicine and Physiology in 1933 ; and the foreign membership of the Royal Society.

In Great Britain, Morgan's name has always been respected, although, led by our own protagonist Bateson, we have not always seen eye to eye with him. Now, however, his great work has convinced the most sceptical among us. No longer is *Drosophila* considered a pariah among living organisms ; rather do we endeavour to interpret the behaviour in other organisms by the aid of the pioneer work of the Morgan school.

F. W. Sansome

Prof. William Peddie

Prof. William Peddie, who died at his home in Dundee on June 2, was born in Papa Westray, one of the most northerly islands in Orkney, in 1861. He was a son of the manse, his father being a minister of the Free Church of Scotland. He was educated at Kirkwall Grammar School, learning to be a sailor as well as a mathematician—a friend speaks of being compelled to admiration by his superb handling of their craft in a nasty bit of sea. In 1880 he entered the University of Edinburgh, where he studied natural philosophy under P. G. Tait and mathematics under George Chrystal. In 1883 he was appointed University assistant in natural philosophy and formed a close association with Tait, in whose physical laboratory he worked. In an article on Tait and his work written many years later, Peddie records the intense admiration felt for the great master by all his students : "From the record of his life and work, men who never knew him may come under the magic spell and be enrolled in the list of his disciples". Tait had early expressed the hope that the large subject of natural philosophy would before long be represented by two chairs. The first step was taken in 1892, when C. G. Knott was appointed lecturer in applied mathematics and W. Peddie lecturer in natural philosophy.

The Harris chair of physics in University College, Dundee, was instituted in 1895, and when J. P. Kuenen, its first occupant, returned to the Netherlands, William Peddie was appointed as his successor in 1907, holding also the title of professor in the University of St. Andrews. On his retirement in 1942 he received the honorary degree of LL.D. from the University of St. Andrews and the title of emeritus professor. Peddie was an active fellow of the Royal Society of Edinburgh and a D.Sc. of the University of Edinburgh (1888).

Peddie's interests in science and philosophy were wide ; his scientific work was concerned mainly with thermodynamics and the equipartition of energy, torsion and torsional oscillations of a viscous wire, and in later years with colour in its various aspects and Weber's theory of magnetism. In addition to elementary text-books and contributions to Cham-

bers's "Encyclopædia", he wrote a treatise on "Colour Vision" (1922), and also a work on "Molecular Magnetism" (1929). He married in 1891 Jessie Isabella Dott, to whom these two works were dedicated: during her long illness he was her devoted attendant.

To me personally, since our first meeting in 1923, Peddie was always extremely kind, and my most pleasant memory of him sees him seated in the secluded garden of his home at "The Weisha", where the birds were so tame that they fed from his fingers.

H. S. ALLEN

NEWS and VIEWS

Chester Beatty Research Institute: Retirement of Prof. E. L. Kennaway, F.R.S.

AT the end of the present academic year, Prof. E. L. Kennaway will retire from the directorship of the Chester Beatty Research Institute of the Royal Cancer Hospital and from the chair of experimental pathology in the University of London which he has held since 1931. Prof. Kennaway and his colleagues have studied the problem of carcinogenesis for more than twenty years and have made outstanding contributions to the problem of cancer. The pioneer work of W. V. Mayneord and I. Hieger at the Royal Cancer Hospital upon the fluorescence spectrum of coal tar led to the discovery of the first known organic carcinogenic compound, 1 : 2 : 5 : 6-dibenzanthracene, and to the isolation from tar of the more rapidly acting compound 3 : 4-benzpyrene, which was identified afterwards by J. W. Cook and C. L. Hewett. The team of workers at the Royal Cancer Hospital, being the first to produce cancer in animals with pure substances of known chemical structure, continued to take the lead in this field of research, and now about three hundred carcinogenic substances are known. The careful and extensive researches have revealed correlations between chemical structure and carcinogenic action. The knowledge obtained has been used and followed up by research workers in all parts of the world. In collaboration with Mrs. Kennaway, Prof. Kennaway has also investigated the distribution of cancer in men of different races, social classes and occupations. His work has been recognized by the award of the Baly Medal of the Royal College of Physicians (1937), the Walker Prize of the Royal College of Surgeons, the Anna Fuller Memorial Prize (with the other workers named above, in 1939), and a Royal Medal of the Royal Society (1941). Although he is relinquishing the directorship of the Institute for which he has done so much, students of the cancer problem hope that he will not entirely abandon the problems of cancer.

Dr. Alexander Haddow

DR. A. HADDOW, who has been appointed to succeed Prof. Kennaway as professor and director, has been working at the Royal Cancer Hospital since 1937. Dr. Haddow was a student and later lecturer in bacteriology in the University of Edinburgh, where he worked on problems connected with the phenomena of dissociation and variation of bacteria and on the pathology of growth. Since 1935, when he first described the growth-retarding effect of the carcinogenic substances, which had been prepared at the Royal Cancer Hospital, Dr. Haddow has carried out a great deal of work on the inhibition of both normal and malignant growth. He has also published work on the effects of synthetic œstrogens on cancer in man, the action of urethane in leukæmia, the carcinogenic activity of derivatives of aminostilbene and on the curious effect of certain *iso*-alloxazines in inducing colour change in the hair of animals. Dr. Haddow's long connexion with the work of the Chester Beatty Research Institute of the Royal Cancer Hospital and his energy and enthusiasm should help to maintain the outstanding position which the Institute has in the field of cancer research. He is a member of the Grand Council of the British Empire Cancer Campaign.

British Beekeepers' Association: Research Committee

THE British Beekeepers' Association, recently re-organised, has now established a series of committees to pursue further the numerous interests of its members. Among these is a research committee the primary function of which is to foster co-operation in research, and to co-ordinate research activities. It seeks also the establishment of a clearing house for information and for the results of contemporary research. The object of bee-keeping is commonly regarded as the production of honey, but the national interest is even better served by the pollinating activities of the foragers, a service which has been reliably valued in Great Britain alone at £4,000,000 a year. At the same time, the craft affords a fascinating hobby for amateurs whose activities, being spread throughout the country, are of greater national importance, for the reason indicated, than are those of the commercial honey producers. The amateur finds not merely a hobby which may be turned to profit, but also an interest in many branches of science. Nevertheless, methods of management are subject to many errors due to tradition and pseudoscience. To deal with such matters, co-operation is essential, because there are so many variables that the individual can seldom conduct an experiment on an adequate scale and is too frequently deceived by an element of chance. Most that is known in the craft has been the result of the enthusiasm of independent observers. The British Beekeepers' Association's Research Committee realizes the importance of amateurs, and is anxious to get into contact with them whether members of the Association or not. The Committee is also hoping to get into touch with those concerned in researches in other fields which are of interest to beekeepers. Communications should be sent to the chairman of the Research Committee, Mr. E. B. Wedmore, Totease House, Buxted, Sussex.

Post-War Astronomy

DR. R. O. REDMAN has put forward a number of interesting predictions about the future of astronomy (*Observatory*, 66, 828; October 1945). It is suggested that astronomy will have a hard struggle to survive except in so far as it is required for time service, for

navigation and surveying; or except for the part of solar physics which has an immediate bearing on terrestrial affairs. It is admitted that a very strong utilitarian case cannot be made out for modern astronomy and, in spite of apparent exceptions, much stronger arguments for astronomy can be made on æsthetic grounds. Civilized man should have as much appreciation of astronomical discovery as he has of architecture, music, the drama, or even of pure mathematics or philosophy. Good popularization of astronomy, as indeed of any science, is a difficult task, and it is suggested that professional astronomers should consider it their duty to devote a certain amount of time to explaining the aims and achievements of astronomy to the general public, or even to fellow men of science, who are sometimes very ignorant of the subject.

Financial problems may be acute in the future needs of astronomy, and a great weakness in the organisation of astronomy hitherto has been the existence of so many small units. Fusion into a few large units should be economical and would lead to greater efficiency, but it is admitted that the difficulties of fusion are almost unsurmountable. Another unfortunate matter is the erection of telescopes in places where comparatively little use can be made of them, and it does not seem that any great improvement here can be expected in the near future. A much more serious problem is the question of the supply of trained personnel. The absence of new recruits during the War, and the fact that higher salaries have induced some astronomers to turn their attention to other branches of science, are serious factors and will have a profound effect on astronomy for some time. On the other hand, post-war technical developments may push observational astronomy into new channels—perhaps a V2 rocket will be able to take an ultra-violet spectrograph above the ozone layer of the earth's atmosphere. Finally, although astronomers in different countries may resume friendly co-operation, nevertheless travelling may be expensive and hedged about with restrictions, so that international co-operation may not materialize on the scale that we desire. At the end of the article it is suggested that, "The enthusiasm and ability of amateurs, to which we have owed so much in the past, may yet prove the principal means of salvation for astronomy in a difficult future".

Bats and their Ways

On p. 46 of this issue, Dr. Donald R. Griffin deals with the extension of the work he did, in association with Dr. Robert Galambos, on the supersonic cries of bats. In the July issue of the *National Geographic Magazine*, Dr. Griffin gives a descriptive account of his work on bats, with several excellent photographs showing the winter haunts of bats, their movements in flight and the laboratory equipment devised to test their power of avoiding obstacles. During his investigations, which have extended over the past fourteen years, Dr. Griffin has given particular attention to bats of New England, including many species of the little brown bats (*Myotis*), pipistrelles (*Pipistrellus subflavus* and related species) and the big brown bat (*Eptesicus f. fuscus*). Some 13,000 bats have been marked with aluminium bird bands, from the recovery of which it has been ascertained that they have good powers of homing; and although the 'cave bats', as they are termed, hibernate, they also are known to migrate distances up to 150–170 miles to find, or return to, suitable winter quarters—often disused mine-workings and limestone caves. The use of the high-speed camera with simultaneous cinematograph pictures shows that, when flying, bats make about fifteen strokes of the wing each second and that their flying speed is approximately 10 miles an hour.

Universities Federation for Animal Welfare

"A time of great activity lies before us," says the annual report for 1945 of the Universities Federation for Animal Welfare, and all who have at heart the interests of animals and the attitudes of man towards them will wish that activity great success under the new president, Dr. E. Hindle. The Federation's contacts with the Parliamentary and Scientific Committee have widened its influence. An alteration in the regulation regarding the preparation of vaccine lymph has been amended in response to the Federation's representations to enforce the killing of the calf before the lymph is collected. Regulations concerning the open trapping of animals and the control of rabbits are being discussed with the Ministry of Agriculture. Among the Federation's principal aims are the introduction of humane methods of pest control, and much thought and consultation with other organisations have been given to methods of destroying rats. The Federation hopes to issue shortly its "Handbook on the Care of Laboratory Animals", which Messrs. Baillière, Tyndall and Cox are to publish. The expert information in this book should make it valuable, not only to laboratory workers, but also to many others. Nine lecturettes for children have been added to the Federation's publications, and the film library has been greatly appreciated by schools. A feature of the Federation's publications are the drawings by its honorary artist, Fougasse.

Dry Rot in Wood

A fourth edition of the brochure on "Dry Rot in Wood" has been issued from the Forest Products Research Laboratories, under the auspices of the Department of Scientific and Industrial Research (Bull. No. 1. H.M. Stationery Office, London, 1945). As a reason for the re-issue, it is said that, since the outbreak of war, dry rot has become much more prevalent, owing to the general neglect of the upkeep of buildings, and damage caused by bombing, to which may be added fire damage. Serious and extensive outbreaks of dry rot developed in a number of buildings after fires caused by incendiary bombs. Much of this rot might have been avoided had certain precautions been taken. In the re-issue of the Bulletin, new material has been incorporated, and the section dealing with new buildings has been revised; certain precautions being necessary to prevent decay in timber in some of the newer types of construction now coming in use. Dry rot has always been one of the more or less concealed dangers in a house—especially in old houses in the ground floors or beneath them, or in old staircases and rooms in the upper portions of old buildings. It is the result of the operations of fungi, and not of insects—the attacks of the latter being usually discernible by the presence of small pin or 'shot' holes in the wood. The attacks are held to be due to faulty building. Doubtless this contention is strictly true; but there are many delightful old buildings in which any alterations would detract from their beauty, faulty

as this construction may be from the point of view of dry rot. The new edition of this Bulletin may be strongly recommended to those responsible for present building programmes, so that features likely to encourage dry rot may be avoided.

South Australian Museum

AMONG the scientific papers mentioned in the report of the South Australian Museum for the period July 1, 1944, to June 30, 1945 (Adelaide, 1945) is one by H. Womersley, "Acarina of Australia and New Guinea. Family Leeuwenhoekiidæ" (*Trans. Roy. Soc. S. Australia*, 69, (1), 96). Mr. Womersley has published several other papers on the Acarina in the *Records of the South Australian Museum*, notably, in collaboration with Dr. W. G. Heaslip, on the Trombiculinæ or itch mites, certain species of which have been responsible for scrub-typhus and scrub-itch among troops operating in New Guinea and the Pacific Islands. The taxonomic research on these has been centred in the South Australian Museum. Numerous specimens of Trombiculinæ were collected by Dr. Heaslip in North Queensland, and by Dr. C. M. Gunther in New Guinea during their researches upon typhus fevers during the war period. It is reported that the Board has had under consideration the possibility of post-war extension of the Museum. The present congestion of both exhibition and storage space is acute, and it is now felt that the condition endangers the proper conservation of the collections, many of which are of a unique character and of inestimable value. The report also refers to needs in respect of the Museum's educational work, especially that connected with visiting school-classes. Hitherto the greater part of this service has fallen upon members of the scientific and technical staffs; but it is now felt that the position results in the inadequate employment of specialized qualifications. The situation could be relieved if the Education Department were to appoint two special teachers to act in co-operation with the Museum staff and to take charge of the school classes. It is pointed out that a similar arrangement is in operation in other Australian museums and that it has proved highly successful.

Introduction to Archæological Method

No. 1 of the Handbook Series produced by the South African Archæological Society is entitled "Method in Prehistory" and is by A. J. H. Goodwin (Cape Town. 12*s*. 6*d*.); it is an extremely useful little book. Prehistoric archæology, whether in Europe or in South Africa, is a fascinating hobby subject, and as such is being increasingly taken up. But there are branches of the subject which are somewhat technical, as, for example, the processes which were used in the manufacture of the tools found, and their classification when collected in the field; also irreparable damage can be done to archæological sites if amateur investigators without knowledge and experience start to excavate unaided. Some kinds of site are so common that little harm is actually done; but there are other rarer types, for example, cave sites or barrows, where the inexperienced amateur may do irreparable damage. Goodwin's book provides just that approach to prehistoric study which many people need. There are chapters on the scope of prehistory, on materials and technology, on field research and excavation, on the preservation and packing of material, on nomenclature, and on the outfit required by an investigator. There is also a useful if short bibliography.

Literature on Soil Insecticides

THE Imperial Institute of Entomology has done good service in issuing "A Review of the Literature on Soil Insecticides" (Imperial Institute of Entomology, 41 Queen's Gate, London, S.W.7. 10*s*.). Since the subject is one of wide interest and economic importance, it is a great advantage to have so much scattered information brought together under one cover. The work took its origin at a Conference on Insecticides and Fungicides of the Agricultural Research Council, which decided to ask Dr. H. C. Gough to prepare the review now before us. The period covered by this work begins in 1914 and ends, except for a few references, in 1940; owing to war conditions, its publication at an earlier date was impracticable. In order to ensure as wide a circulation as possible, the Agricultural Research Council delegated the publication of the review to the Imperial Institute of Entomology. The subject-matter of the review is extremely well arranged under the chemicals employed. The most important of these are grouped together and arranged alphabetically. The remaining substances, also arranged alphabetically, follow; but they proved difficult to classify owing to their being often referred to by different authors under different names. Many foreign names also proved difficult to translate owing to their often having different significance in different languages. A perusal of the 150 or more pages of this work shows how contradictory so many of the results obtained by different authors have been for almost all the substances tested. It is, therefore, impossible to draw any but very limited conclusions. This in itself is a cogent argument for renewed and carefully controlled experiments. Also the need for a full analysis of the diverse factors likely to influence the results of experiments has to be constantly borne in mind. A very fair indication of the extent of the subject of soil insecticides is given by the bibliography at the end of this review, in which more than 650 works are listed.

Synthetic Philosophy of the Seventeenth Century

IN his Herbert Spencer Lecture for 1945, "Synthetic Philosophy in the Seventeenth Century: a Study of Early Science" (Oxford: Basil Blackwell. 2*s*. net), Canon C. E. Raven maintains that popular writers on the history of science are giving us a defective account of the breakdown of the medieval and the development of the modern world, and a caricature of the characters and intentions of the founders of the Royal Society; their metaphysical and religious interests are minimized and the progress which they made towards a synthetic philosophy ignored. Secondly, he points out that almost all the recent histories of science neglect the biological sciences, and especially botany and zoology, treating the subject as if mathematics were the sole primary theme, with astronomy and physics as its derivatives. Canon Raven contends that the remarkable group of men who gathered as the 'Invisible College' meeting at Cambridge, inspired by Robert Boyle and John Wilkins, and expanded in 1662 into the Royal Society, not only brought Britain into the front rank intellectually and almost succeeded in creating an alternative for the medieval synthesis, but were also men of sincere and deep religious conviction, and

possessed of a genuine passion to see life as a whole and no less genuine faith that in the study of the "works of creation" they were enlarging man's knowledge of the wisdom of God. They pursued a synthetic philosophy, and the progress they made in the half-century of their greatness was large in extent and true in direction. Though they accepted data which we with nearly three centuries of further study rightly reject, it was their catholicity of outlook, and their willingness to prove all things, that made possible the speed and range of their achievements. If they had been less hospitable to old or new, if they had refused fresh notions through subservience to the past or renounced authority recklessly and in revolt, they would neither have laid the foundations for scientific inquiry nor effected so large and permanent a revolution. Canon Raven believes that it is arguable that there has never been so fine an attempt to formulate a synthetic philosophy as that which the Cambridge Platonists projected and Culverwel succeeded in expressing. Like the best of the medievals, they saw the world as emblematic or sacramental: like the best of the moderns, they strove to see it objectively and accurately.

Hospital Staffs and Working Conditions

THE urgency of the recent appeal for more nurses, midwives and domestic hospital workers is clearly set forth in the Government booklet "Staffing the Hospitals, an Urgent National Need" (H.M. Stationery Office, 1945. 3*d*. net). This booklet gives details of the unanimous agreement reached between the Government and the various hospital organisations. The Minister of Health, the Secretary for Scotland and the Minister of Labour and National Service say that "the situation is serious already. It is likely soon to become critical unless thousands of new recruits can be obtained quickly." The Government and the hospital authorities have agreed upon salary increases, improved working conditions and prospects, the formation of a national reserve of nurses, much-needed reforms such as the employment of married and part-time nurses and permission to live out of hospital, the training of more male nurses and the formation of a grade of 'ward orderlies' to assist the nurses. A National Joint Council for England and Wales has been formed to regulate the terms and conditions of service of hospital domestic workers. Further details of the proposed reforms are given in a memorandum issued with the booklet just mentioned. Certainly reform of the lot of the hospital worker has been, as every medical man will testify, overdue for many years. Without it we can scarcely hope to obtain enough workers to operate any national health scheme.

Generation and Regulation of Electric Power in Aircraft

A PAPER by I. O. Hockmeyer (*J. Inst. Elec. Eng.*, 93, Pt. 2, No. 31, February 1946) records the development of the generation of D.C. power in aircraft by windmill- and engine-driven generators, from its inception to the present day. Features of generator design which have called for special consideration, or have been the subject of failure, are discussed. Sections are devoted to the choice of speed range, brush wear at high altitude, systems of ventilation, design of end-frames, and bearing failure. Some mention is made of generators designed for power supply to radio equipment, as distinct from general power services. These generators, which include high-voltage D.C. machines and high-frequency A.C. machines, have been combined with low-voltage D.C. machines, both in tandem and with a common magnet system.

The latter part of the paper deals with voltage regulation in so far as generator design is influenced by the system adopted; self-regulating generators of various types have been used from time to time in the past. Brief mention is made of the design of the several types of regulator which have been used, including Tirrill and carbon-pile types. The paper shows how the control of the system voltage had been conditioned by the inclusion of an accumulator, and how it has not been possible to devise a system which gives the constant line voltage required for current-using devices, and, at the same time, permit of adequate control of accumulator-charging current. Systems of paralleling, and their effect on line voltage, are also described.

Small Two-phase Induction Motor

A SPECIALLY small motor, developed in the Admiralty Compass Department for use in applying torques for controlling the precession of the gyros of the Admiralty Gyro Transmission Unit Mk. II, has now been described. The motor is totally enclosed and has an aluminium alloy shell and end shield. The rotor is mounted in ball bearings and the weight of the complete motor is 5½ oz. It is suitable for use in tropical countries. The stator core consists of radiometal laminations 0·010 in. thick. The stator windings are of the double-layer concentrated type, the individual coils being preformed and inserted in the 12-slot core to form a 2-phase 6-pole system. The squirrel-cage rotor is formed by copper strips secured in narrow slots in the laminations; the twenty-one slots are skewed by one slot pitch to eliminate cogging. The shaft is of stainless steel. The deep narrow rotor bars and open-ended slots assist in providing a relatively flat speed-torque characteristic, since at high slip frequencies the current in the bars is concentrated towards the outer edge giving effectively greater rotor resistance at low rotor speeds. As a torque motor, the machine was required to operate on 333 c./s. and works continuously under standstill conditions, with a temperature rise at 20 volts/phase of about 30° C. As a follow-up motor, at a frequency of 400 c./s., one phase is constantly energized, while the second phase is supplied from the output of a valve amplifier in proportion to the misalignment of following. Under these conditions a fixed phase voltage of 30 volts gives a temperature rise of about 30° C. in normal operation.

General Purpose Source-unit for Spectrographic Analysis

FOUR main types of light source are used for the spectrographic analysis of metals and alloys. They are the low-voltage D.C. arc, the high-voltage A.C. arc, the condensed spark either controlled or uncontrolled, and the low-voltage discharge initiated by a low-energy, high-voltage spark. Since they require only simple and inexpensive equipment, the D.C. arc and the uncontrolled condensed spark are generally used in Britain, the arc for work of high sensitivity but not high accuracy because of its instability, the spark for accurate analysis. For the accuracy and wide field of application required by present-day

analysis it is necessary to have available not only the arc and the condensed spark but also the wide range of excitation conditions intermediate between them. A. Walsh (*Bull. Brit. Non-Ferrous Metals Res. Assoc.*, No. 201, 60, March 1946) has constructed such a source unit, which provides a simple condensed spark, a low-voltage D.C. arc, and, by using a triggered low-voltage discharge, a whole series of intermediate excitation conditions. The circuit, described fully in the paper, is similar in principle to that of Hasler and Dietert (*J. Opt. Soc. Amer.*, 33, 218; 1944) but totally different in detail, particularly in regard to the method of triggering and the electrical constants of the discharge circuits. The results of some experiments performed with the new source unit on aluminium-base, zinc-base and lead-base alloys are given in tabular form. These indicate that a high degree of reproducibility is obtainable with the new type of source and that the accuracy is higher than is possible with a simple condensed-spark unit.

A White Blackberry

W. A. MURRELL (*J. Hered.*, 36, 21; 1945) has found that the white sand-blackberry is recessive to the normal colour. It is fruitful and may under cultural conditions be improved in flavour and size; it has the advantage that it does not stain the hands and teeth. It has been found to be self-incompatible, and at present will only set when crossed with the normal sand-blackberry.

Embryos from Unborn Mothers

W. L. Russell and P. M. Douglass (*Proc. Nat. Acad. Sci.*, 31, 402; 1945) have been able to transplant mouse ovaries from embryos *in utero* to females 40 days old. After mating these host females, normal offspring were obtained from the transplanted ovaries. This fact will prove useful in various investigations.

Wellcome Veterinary Research Fellowship: Mr. J. B. Polding

MR. J. B. POLDING has been awarded a Wellcome veterinary research fellowship by the Veterinary Educational Trust, to undertake work upon the metabolism of *Brucella abortus*, the causal organism of bovine contagious abortion. Mr. Polding, who has previously carried out investigations in Malta and in India on undulant fever in man and on bovine abortion, will work in the Biochemistry Laboratories at Oxford under the supervision of Prof. R. A. Peters and Dr. D. D. Woods. The award of this fellowship brings the total of research awards made by the Trust to nine. The problems being investigated include a study of structure and function in domestic animals, worm infestations of equines, staphylococcal infections of animals, blowfly problems of the sheep, contagious bovine abortion, resistance of animals to parasitic infestation, and equine infertility. It is hoped shortly to make a further appointment for work upon animal nutrition.

Conference on Fuel

THE Fuel Efficiency Committee of the Ministry of Fuel and Power, under the chairmanship of Dr. E. S. Grumell, has arranged a conference on "Fuel and the Future" to take place in London during October 8–10. During the intervening months, a campaign to promote fuel efficiency and fuel economy is being undertaken by the Ministry through various agencies, and the Conference is intended to focus attention on development during the next five to seven years, and on the fuel savings that can be made, in industry, non-industrial premises and homes, with the aid of the new equipment now becoming more readily available. Most of the sessions will be held at the Central Hall, Westminster. The opening session on October 8 will be addressed by the Minister of Fuel and Power and by the Minister of Health. Afterwards the Conference will meet in eight separate sections, six of which will be concerned each with one group of industries having related fuel problems, one with the problems of architects in connexion with new housing, and one with women's views on domestic heating. On the morning of October 10, there will be general discussions on the "Sizing and Grading of Coal" and "District Heating", while in the afternoon the Minister of Fuel and Power will take the chair at the closing session, when the sectional chairmen will survey the proceedings of their Sections. Particulars of the meeting can be obtained from the Ministry of Fuel and Power, Fuel Efficiency Directorate, Queen Anne's Chambers, Tothill Street, London, S.W.1, or to any Regional Office of the Ministry of Fuel and Power. The Institute of Fuel is co-operating in the Conference and has accordingly arranged for the Melchett Lecture to be given on October 8; the annual reception, dinner and dance of the Institute are to be held on October 9.

Indian Plywood Tea Chests

IN the published results of research work, clarity and brevity should be among the objectives aimed at if the work is to be appreciated by the non-expert. More especially is this the case where the results of the research are to be useful in industries and so forth. In the article entitled "Indian Plywood for Tea Chests" published in *Nature* of December 1, 1945, certain types of plywood tea chests are referred to. In *Indian Forest Records*, vol. 3, No. 4, dealing with this subject, in the summary, nine different types of tea chests are said to have been subjected to systematic scientific tests. In the text itself they are quoted in a table under the heading "Type of Box" as 'O, 14–14–14': 'S, 14–14–14' and so forth. In the summary it is said, "The 'O, 14–14–14' and 'S, 14–14–14' types of plywood tea chests are found to be stronger . . ." The writer of the article in *Nature* took this to mean 14 in. × 14 in. × 14 in. in size; since, in the pamphlet, both the 'O, 14–14–14' and the 19 in. × 19 in. × 24 in. are referred to as "plywood tea chests". Apparently the figures given under "type of box" (namely, O, 14–14–14) refer to the thickness of individual plies in parts of an inch, and not to the size of the chests in inches. It is a pity that this was not made clear in the pamphlet.

Announcements

THE seventy-fifth anniversary of the foundation of the Observatory of Cordoba is being celebrated by a joint meeting arranged by the Observatory and the Argentine Physical Society to be held during September 20–23, 1946.

WE have been asked to state that the closing date for applications for appointments at the Indian Institute of Science, Bangalore (advertised in *Nature* of July 6, p. iii), has been extended to August 6.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Wilt Disease of the Oil Palm

DURING recent investigations in the Belgian Congo I came across what is apparently a hitherto undescribed wilt disease of the oil palm (*Elaeis guineensis*). Palms of 4–20 years of age have been seen with characteristic necrotic symptoms in the vascular strands of the trunk and roots. The destruction of well-grown palms has been observed in widely separated areas. The lower leaves of such palms show characteristic flagging and wilting; they eventually break near the base of the petiole and hang down in a cluster around the trunk. The younger leaves are successively affected until eventually the whole crown is destroyed and the plant dies (Fig. 1). Wilting may proceed quickly even in the wet season. Affected leaves may show some development of yellow colour, but in many wilting palms there is no abnormal leaf coloration.

The indications are that the vascular system of the trunk becomes infected by way of diseased roots or through wounds in the base of the trunk. Vascular strands, which are normally of a pale yellow colour, turn a greyish-brown to black colour as a result of infection (Fig. 2). The infection is at first most strongly developed in the more peripheral strands of the trunk, but later the central strands also become discoloured; many irregular distributions of discoloured strands have also been observed. The infection eventually spreads upwards in the trunk and even into the crown of the plant, where very marked vascular symptoms may sometimes be observed. Discoloured vascular strands have also been observed in the bases of the crown leaves.

The presence of fungal filaments in necrosed wood vessels was ascertained in microscopic preparations. The same species of *Fusarium* has been isolated on a number of occasions from different localities. Needless to say, this aspect requires much amplification, and inoculation experiments will be necessary before a definitive diagnosis can be given. The presence of the pathogen in the wood vessels is attended by an exudation of gum by which the vessels become blocked. Bacteria were not observed in the vessels.

In some respects this disease of the oil palm closely resembles the wilt disease of bananas (caused by *Fusarium oxysporum cubense*); in others, it presents many new and puzzling features. In some areas the disease, which is also present in natural palmeries, has already taken a considerable toll of plantations either in a direct or accessory capacity. From these brief observations it will be evident that this disease should be studied in all its aspects as soon as possible in the general interest.

Fig. 1

Fig. 2

C. W. WARDLAW

Department of Cryptogamic Botany,
University of Manchester.
June 14.

Plant Tumours Induced by the Combined Action of Wounds and Virus

IN an earlier paper[1] various symptoms of wound-tumour disease, such as stunting, vein enlargement, leaf distortion and tumours, were described on several of the numerous hosts of the causal virus *Aureogenus magnivena* Black[2]. The present communication deals principally with the role of wounds in tumour inception in diseased plants. Fig. 1 illustrates the kind and number of tumours present on the roots of infected sweet clover (*Melilotus alba* Desr.). A cross-section through a root bearing a tumour (Fig. 2) shows the practically normal portion of the root enclosed within the black line. In this area the parts are, for the most part, regularly arranged. The rest of the section is tumour tissue. It shows several centres of growth, the margins of which are marked by deeply stained meristematic cells with prominent nuclei. The meristematic cells are surrounded by a layer of crushed cells and enclose parenchyma and vascular elements. The xylem is prominent and reveals the highly disorganised condition of the tumour tissue. It may be arranged in whorls or it may be so disorganised that two adjacent xylem elements are disoriented in regard to each other. Affected cells frequently show spherical bodies that stain intensely with safranin. No organisms have been observed in such sections.

Experiments have confirmed the suggestion advanced earlier[1] that tumours produced in wound-tumour disease arise as a result of wounding plant tissues systemically invaded by the wound-tumour virus. In one experiment insect pins 0·25 mm. in diameter were used to make single punctures at the mid-internodal points on stems of systemically infected sweet clover plants (white melilot) (*Melilotus alba* Desr.) and corresponding healthy plants; 175 tumours developed from 387 punctures on infected stems, whereas no tumours developed from 505 control wounds on healthy stems. The younger the tissue injured the greater the proportion of wounds from which tumours developed. Tumours began to be visible to the naked eye as early as seven days after wounding, and most tumours became visible during the second and third week after wounding. By the end of the fifth week, it appeared that if a tumour had not developed at the site of a wound, there was little chance that it would develop there afterwards. A single pin puncture in a terminal node of a diseased plant gave rise to several tumours scattered along the stem.

The locations of naturally occurring tumours on infected plants also suggest the important part played by wounds. 146 very young

Fig. 1. TUMOURS ON THE ROOTS OF A SWEET CLOVER PLANT INFECTED BY WOUND-TUMOUR VIRUS. (× 0·5.) (PHOTOGRAPH BY J. A. CARLILE)

Fig. 2. CROSS-SECTION OF A ROOT BEARING A TUMOUR. (× 35.) (PHOTOGRAPH BY J. A. CARLILE)

root tumours on diseased sorrel (*Rumex acetosa* L.) were examined under a dissecting microscope. Of these, 79 per cent were in immediate juxtaposition to lateral roots which always cause wounds in the mother root from which they emerge. These small root tumours arise in the mother root above, below or at the side of the lateral roots. They apparently do not arise, or very rarely arise, on the mother root opposite to the lateral root. It is possible that the 21 per cent of tumours without obvious connexion with lateral roots were associated with unknown wounds. While one cannot be certain that tumours arise in infected tissues only where wounds are made, it is clear that a high proportion occur at such loci.

That the tumour tissue is capable of indefinite growth without the differentiation of normal plant organs can be shown by grafting small pieces of tumour tissue to healthy plants. The tumour-scion grows as a tumour in the new site and the stock plant eventually develops tumours elsewhere. It is also illustrated by the fact that tumour tissue from sorrel has been grown for twenty months on White's medium[3] without the production of roots, stems or leaves. Such tissue cultures grow slowly, the best cultures doubling in volume about every three weeks. They are free of cultivable bacteria and fungi. When tissues from these cultures were successfully grafted to healthy sorrel plants, the plants developed the systemic disease, showing that the virus was still present in the tissue cultures.

In a limited number of experiments the wound-tumour virus was not mechanically transmitted by the carborundum method[4]. The virus has specific insect vectors[2]. There would seem to be little doubt that this plant virus disease is homologous in many ways with virus tumour diseases of animals such as virus tumours of chickens, condyloma acuminata of man, virus tumours of rabbits, carcinoma of leopard frogs, and mammary carcinoma of mice[5].

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[1] Black, L. M., *Amer. J Bot.*, **32**, 408 (1945).
[2] Black, L. M., *Proc. Amer. Phil. Soc.*, **88**, 132 (1944).
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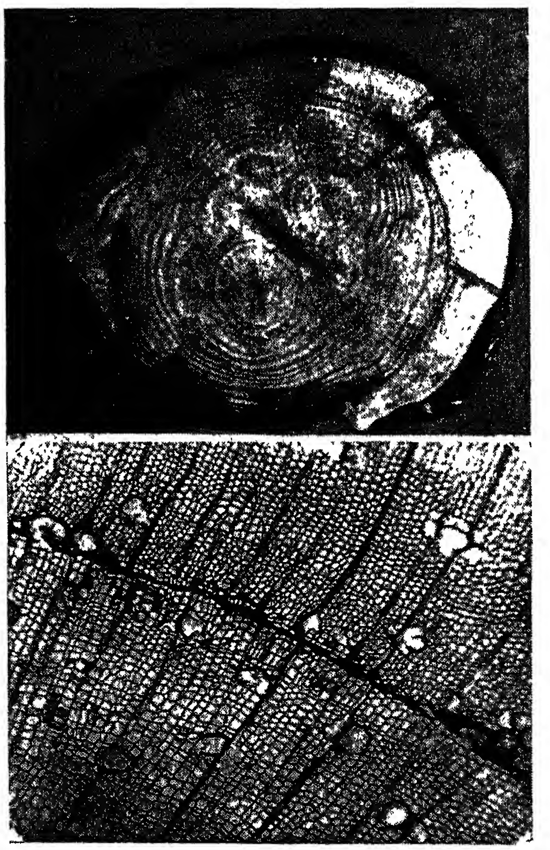
Root Disease in Conifers

ROOT disease in coniferous trees, other than those which are small seedlings, has mainly been associated with the fungi *Armillaria mellea* (Fr.) Quel. and *Fomes annosus* (Fr.) Cooke. Field observations over many years have led one to believe that frequently some of the more important factors which predispose to infection and indeed are themselves often important causes of disease are to be found in adverse physical conditions which arise in the soil.

Field studies of the relationship between soil conditions and pathological root development are, however, difficult to carry out and, perhaps mainly for this reason, satisfactory explanations of the etiology of root disease in conifers have been lacking. The discovery in diseased pine roots of zones of abnormal tissue which clearly are of non-parasitic origin is, therefore, of some considerable interest. These zones were first seen by me some twenty years ago, in the root of a Corsican pine the crown of which showed no obvious signs of disease. By their position in the wood, they were plainly associated with the dry growing-season which occurred in 1921. Afterwards, Day and Peace (ref. 1, p. 40) produced such zones experimentally in European larch and oak by subjecting the roots of small trees either to drought or to waterlogging. They were discovered again, in 1944, in roots of a Corsican pine, part of the root system of which had been colonized by *A. mellea*. In this case their development seemed clearly to be associated with the dry periods which occurred in 1933 and 1934. It is of still greater interest that they have been found on the roots of



Scots pine dying in plantations in three different regions of East Anglia. *Fomes annosus* occurs on these trees and a species of *Phytophthora* has also been isolated from them. These trees consistently bear roots from which, on dying, resin flow has taken place to such an extent that a mass of resin-soaked soil usually adheres to them: their wood also is more or less soaked in resin. This is not typical of roots attacked by either *A. mellea*, *F. annosus*, or, according to recent experience in South Wales, of roots infected by *Phytophthora* species either. It has, however, been found before in pine roots in which abnormal zones associated with water deficiency occur.

The accompanying photographs show well-developed abnormal zones in roots cut from the East Anglian pines. The complete root-section was about three inches across. It will be seen that the bark of the root died down to the wood in places; frequently, however, only the outer part of the cortex dies, as is so often the case in frost-injured stems. These abnormal zones consist of unlignified collapsed tracheids. The upper part of the soil profile, in which the root systems of the affected trees grow, is sandy and subject to drought during any considerable dry period; the lower part of the profile consists, according to the district, either of re-cemented chalk or compact sand, both of which are very water-retentive. Dead roots and also roots in which abnormal zones occur may be found in both these parts of the soil profile and the evidence is, thus, that they arise both owing to drought and to waterlogging.

This East Anglian disease of pines appears, therefore, as a very interesting case in which severe injury to the root system has first developed owing to adverse physical conditions in the soil. Infection by fungi, although perhaps of considerable importance in the development of the disease and in bringing about the death of trees, appears as secondary to strongly adverse physical soil factors. This is, of course, a diagnosis which can be proved in detail only by long-term research. The evidence provided does, however, bring out strongly the very important part that can be played by non-biotic factors in the development of root disease, and stresses the need for soils research which is designed to show in what circumstances and with what severity conditions develop in the field which are sub-marginal for healthy root development, either directly or through predisposing roots to infection by parasites.

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June 5.

Day, W. R., and Peace, T. R., "Spring Frosts", Forestry Commission Bull. 18. (London: H.M. Stationery Office, 1937.)

The Protein of Fruits

UP to the present, it has not been found possible to obtain more than an insignificant amount of the protein of apple-fruits in a soluble form except by treatments so drastic as to lead, inevitably, to some degradation as well as denaturation of the protein[1]; other acid tissues, for example, rhubarb leaves[2], behave in a similar way, whereas the protein can be easily extracted from non-acid tissues by water alone after maceration or cytolysis of the tissue.

I have found, recently, that it is possible to extract at least 50 per cent of the protein from apples by adding, a little at a time, the frozen and ground (at − 20° C.) tissue to a warm borate buffer solution (pH 9·2) which is being violently stirred. The protein can be recovered from the filtered solution by adjustment of the pH to 3. The crude precipitate, representing approximately 50 per cent of the protein-nitrogen of the original tissue, has a nitrogen content (ash-free) of 7·2 and gives a positive test for tyrosine and tryptophane and a strong Molisch reaction.

This observation suggests that, *in vivo*, the cytoplasm of the cells of the fruit must be at a much higher pH than that of the vacuolar sap (pH 3 or lower).

Work is proceeding with the object of obtaining larger samples of the apple-protein complex so that its properties may be studied.

This work was carried out as part of the programme of the Food Investigation Board.

A. C. HULME

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May 15.

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[2] Chibnall, "Protein Metabolism in the Plant" (Yale University Press, 1939), p. 145.

A Response to Gravity in Young *Hydra*

WHILE keeping cultures of *Hydra vulgaris* Pallas for class work it was noticed that whereas adult animals seldom changed their position, buds immediately after their separation from the parent rapidly made their way up the side of the tank to the surface of the water. This reaction seemed worthy of further investigation, since previous workers on the behaviour of *Hydra* have not made any distinction between adults and buds. Upward movement has generally been regarded as a response to lack of oxygen or to a gradient in oxygen concentration, rather than as a gravity reaction[1,2,3]. I have found that the upward migration of recently separated buds is a response to gravity and not to lack of oxygen, or to a gradient of oxygen concentration. It takes place both when the water is at air saturation and there is no gradient of oxygen concentration, and also when the oxygen concentration is arranged to be lowest at the top and highest at the bottom of the vessel containing the animals.

Lowering the pH of the water with carbon dioxide has little or no effect on the reaction of young buds; but it evokes upward movement in adults which previously showed no such reaction. An equal alteration of pH produced by adding hydrochloric acid is ineffective. A reduction of the oxygen content of the water to approximately 1 ml. per litre is also without effect on adults, nor does it affect the normal upward migration of young buds.

The interaction of this gravity reaction of young buds and the well-known positive reaction of *Hydra* to light has also been investigated. The buds were allowed to walk on a vertical surface, and the light was arranged to come either from below or from the side in such a way that the rays were parallel to the face on which the animals walked. It was found that bottom light affects the gravity reaction much more strongly than does side light. This is true not only for animals taken from stock cultures in normal lighting conditions, but also for animals that had been grown for two generations in a tank lit from below. Haug[4] has shown that when behaving photopositively *Hydra* orientates itself klinokinetically, and although its oral end may during this orientation often be directed away from the light, the animal will not take a step when the oral end is at a lower intensity of illumination than the aboral end. This has the effect of inhibiting movement upwards when the animal is lit from below. In side light, on the other hand, even if the animal is orientated vertically upwards, walking is not inhibited, since the oral and aboral ends are then equally illuminated. The greater effect of bottom light on the gravity reaction therefore results from the way in which the response to light is made, and is not to be taken as showing that the unnatural direction of the light rays has enhanced their effect and, so to speak, confused the animal.

The biological significance of this negative geotaxis shown by young buds of *Hydra vulgaris* is clear. The reaction ensures the distribution of young buds, and prevents their staying in the immediate vicinity of their parent and so giving rise to local overcrowding.

This work will be published in full in the *Proceedings of the Zoological Society of London*.

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June 17.

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[2] Haase-Eichler, R., *Zool. Jb.*, **50**, 265 (1931).
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Bacterial Origin of Some Insect Pigments

THE literature on symbiosis, as summarized in Buchner's[1] latest book, refers almost entirely to histological and cytological findings. Little work seems to have been done on the isolation of the symbiotes, and less still on their physiological role in insect metabolism. Koch[2] was the first to prove that the symbiote of *Sitodrepa panicea* provides a growth-promoting factor or vitamin for this insect. With regard to *Cicadella viridis*, I have published two[3,4] communications showing that the insect contains two bacteria: one on culturing produces a greenish-yellow pigment, identical with the colour of the insect, and the other β-carotene which is apparent at least on the legs of the males. In the female, β-carotene is reduced to the colourless vitamin A, which is needed by the insect.

Orthezia insignis is a scale insect often found in the greenhouses of botanical gardens in Europe. The long bacterium it harbours has been illustrated by Buchner[5] and also by Walczuch[6]. On culturing, it produces a greenish-yellow pigment like the colour of its host. Walczuch also figures the symbiotic bacteria of *Orthezia urticæ*, which, however, are not so happily represented. In smears their shape is like thick short rods rather elliptical at the ends. The bacteria of *O. urticæ* and *O. insignis* can never be mistaken in smears, a feature not well brought out in the illustrations of Walczuch. The symbiote of *O. urticæ* forms a relatively darker green pigment in cultures. When we compare the living adults of the two species of *Orthezia* and also their bacterial cultures, it is clear that the insects differ from each other in colour, *insignis* being yellower and *urticæ* greener, as is also the case with the pigment of their respective symbiotes.

That symbiotic micro-organisms can produce pigments was first suggested by Pierantoni and further elaborated by Tschirch, who unfortunately did not work with living lac insects, and his observations had to be differently interpreted[7]. However, it seems to me that some work has already been published which bears independent testimony to such a theory. In 1912, Buchner[8] reproduced a coloured illustration of an insect larva which could have belonged either to *Aphrophora alni* or *A. salicis*, but he left the species unidentified. The general body of this larval insect is ochre-coloured, but the marginal area of four abdominal segments is red. Buchner clearly indicates in the description of his Plate 11, Fig. 1, on page 115, that the symbiotic organ of this insect is red, the colour appearing through the chitin of the insect. I may add here that the tumour, formerly called 'mycotome', or as it should be called 'bacteriotome', varies in its colour intensity, but there is always a reddish zone which Buchner mentions and illustrates. He also illustrates in Figs. 2–5 histological sections, of the same species, where there are pigment granules resembling burnt sienna rather than ochre, which shows that the pigment was able to withstand the action of the fixative and of solvents like alcohol and xylol. When the adult insects of *A. alni* and *A. salicis* are compared, the former is reddish like burnt sienna, while the latter is ochre-coloured. The symbiotic organs likewise differ in colour when freshly dissected, but not to such an extent as the pigments they contain. Buchner's illustrations leave no doubt that the specimen he illustrated belongs to *A. alni*, the reddish of the two species.

In 1925, Buchner[9] illustrated as many as three symbiotic micro-organisms of *A. alni* (Fig. 10, p. 113). It is a very common insect all over Europe, and it is easy to confirm the illustrations given by Buchner, but the real symbiote is a small bacterium quite distinct from those suggested by him. It is best seen in smears and particularly when the insect is in the larval or young adult stage. Later on, the symbiotic organ becomes sterile and the bacteria are then found

only in the egg. It is the sterile symbiotic organ which shows the three forms illustrated by Buchner at their best; I hold them to be tissue debris. Perhaps the real bacterium has been mistaken for cell-granules and overlooked as such. However, this bacterium produces a red pigment and, moreover, fills the culture plate with a mass of delicate crystals of phosphates. When the cultures become old, the red pigment turns burnt sienna in colour. The observations on the pigments formed by these cultures further enable me to identify Buchner's illustration as belonging to *A. alni*.

Buchner[9] also illustrates the symbiotes of *A. salicis* in Fig. 4, p. 103, which are supposed to be two, one resembling a piece of protoplasm, while the other, the genuine symbiote, is a long thin bacterium. Its culture forms a pale ochre-coloured pigment which, in time, slightly darkens to give the colour of the adult insect. When *A. alni* and *A. salicis* are compared, along with the cultures of their bacteria, there is no doubt that the symbiotes produce the pigments of their hosts.

Buchner[9] likewise illustrates the symbiotic microflora of *Fulgora europea* (p. 175, Fig. 30, *a–d*) with bright yellow pigment granules. The bacteriotome from which these illustrations have been derived is also yellow in colour. The adult insect is greenish, but in alcohol its colour changes immediately to yellow, the green colour being soluble in it. A culture from the above insect gave a colony of bacteria producing a yellow pigment. Other insects like *Philænus* species and *Aphrodes bicintus* also owe their pigments to their symbiotic bacteria.

On account of the high prices of bacteriological materials, nearly all my cultures had to be sacrificed, but those of *Cicadella viridis* are still available, and have been sent to the National Type Culture, Lister Institute, London.

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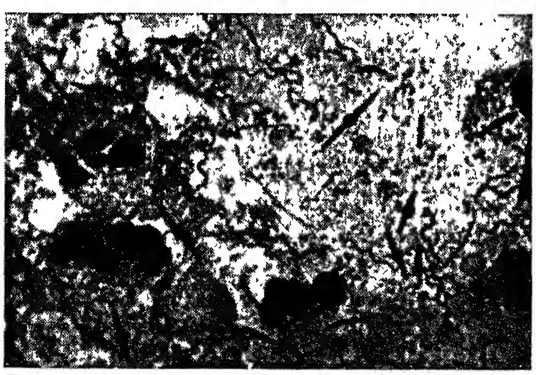
[1] "Symbiose" (Sammlung Göschen, 1939).
[2] *Biol. Zentralb.*, **53**, 199 (1933).
[3] *Verhandl. d. Deutschen Zool. Ges.*, 420 (1939).
[4] *Deccan Medical Journal* (Hyderabad, 1941).
[5] "Tiere u. Pflanze in intrazellular Symbiose", 238, Fig. 67 (1921).
[6] *Z. f. Morph. u. Ökol.*, **25**, 657, 659 (1932).
[7] *Archiv. f. Protis.*, **68**, 613 (1929).
[8] *Archiv. f. Protis.*, **26**, 115 (1912).
[9] *Z. f. Morph. u. Ökol.*, **4**, 103, 113, 175 (1925).

Changes Occurring in *Bacillus fusiformis* During the Application of Penicillin

While investigating microscopically smears of 210 cases of ulcerative gingivitis we found the usual crowd of typical spirochætes and fusiform bacilli. Routine treatment with penicillin produced clinical and bacteriological clearance. In 41 cases the fusiform bacilli showed after treatment with penicillin a peculiar change in shape. Central round or spindle-shaped swellings (see accompanying illustration) of



Large swellings in fusiform bacilli after penicillin treatment. Stained with crystal violet. × *c*. 900

intensively stained plasma were found in varying numbers. These large swellings are obviously an expression of the influence on these micro-organisms by penicillin. These bodies were never observed in untreated cases, or in any other treatment of this condition. A study of this appearance is in preparation.

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Polarographic Determinations in the Presence of Triethanolamine

In a communication in *Nature*, Mr. H. Wolfson[1] reported that iron can be determined satisfactorily on the polarograph if the solution contains triethanolamine. This method seemed promising for the measurement of iron in small quantities, which has hitherto been practically impossible. It would be particularly suitable for use on biological materials and foodstuffs, especially if lead and copper could be measured in the same solution. In Mr. Wolfson's solutions, containing ammonia, copper gives two steps, the second one interfering with that of ferric iron. He stated, however, that the properties of the solution can be considerably modified by the presence of a strong alkali. When this suggestion was followed up, it was found that the steps for copper, lead and iron can be separated and that the three metals can be determined simultaneously under suitable conditions.

The following table contains approximate values for the potential of the mid-point of the step (the 'half-wave potential') for a number of metals in 0·1 *M* potassium hydroxide containing triethanolamine. All are negative and are with reference to the saturated calomel electrode. The figures in potassium hydroxide alone, given for comparison, are taken from Kolthoff[2]; those in 0 4 *M* triethanolamine were communicated privately by Mr. Wolfson.

Triethanolamine	Cu	Pb	Cd	Fe	Ni	Zn
0	—	0·68	—	—	—	1 42
0·03 *M*	0·46	0·76	0·77	1·04	1·35	1·45
0·10 *M*	0·47			1·02		
0·30 *M*	0·53	0·88	0·82	1·01	1·40	1·57
0·40 *M*	0·55	0 91	0·88	1·00	1·45	1·61

In 0·5 *M* potassium hydroxide, 0·1 *M* triethanolamine, the figure for copper is − 0·53 v. and for iron − 1·06 v.

For iron the height of the step can be measured accurately in any of the above solutions, but for copper, lead and cadmium the top of the step tends to be rounded, so that the exact value of the diffusion current is uncertain. This rounding of the step occurs frequently in polarographic curves. Its cause is at present unknown, but it seems to be due to a tendency to form a second complex ion. In 0·03 *M* triethanolamine, 0·1 *M* potassium hydroxide, the uncertainty is negligibly small and the steps are of good form for measuring, but as the strength of either reagent is increased the uncertainty becomes progressively greater. The step for zinc, which is good in potassium hydroxide solution, is poor in all the solutions containing triethanolamine. Nickel gives a poor step in all the solutions and its height is reduced by heating. This suggests that the nickel is not in true solution.

The fact that copper, lead and cadmium can be measured accurately only in solutions containing a small concentration of triethanolamine would seem to limit the application of the method. The solubility of ferric hydroxide in the 0·03 *M* triethanolamine, 0·1 *M* potassium hydroxide solution is probably not much greater than 100 mgm. iron per litre. The solubility of cadmium in the same solution, judging from the height of the step, is about 30 mgm. per litre. Figures have not been obtained for the other metals.

A few tests have been made using triethanolamine in the presence of ammonia, borax and ammonium sulphate respectively. The following are approximate figures for the mid-point potentials in 50 gm. ammonium chloride, 50 c.c. ammonia per litre.

Triethanol-amine	Cu	Pb	Fe	Cd	Ni	Zn
0	0·19, 0·48	—	—	0·80	1·05	1·31
0·03 *M*		0·53		0·78	1·09	1·32
0·30 *M*	0·21, 0·50	0·56	0·56	0·81	1·18	1·36

The steps for cadmium and nickel are good and are little affected by triethanolamine. The step for zinc becomes less satisfactory as the concentration of triethanolamine is increased. Lead and iron are virtually insoluble in plain ammoniacal solution, but give excellent results in the presence of triethanolamine. Copper gives a double step in all these solutions, but otherwise behaves like zinc.

In 0·1 *M* borax, 0·3 *M* triethanolamine, copper gives a single, unsatisfactory step at about − 0·3 v.; iron gives a fairly good step at − 0·70 v. In 0·25 *M* ammonium sulphate, 0·3 *M* triethanolamine, copper gives what appear to be two steps running into each other, with mid-points at about − 0·2 v. and − 0·4 v. The step for iron depends on the *p*H of the solution. At *p*H 4 it is more positive than + 0·3 v.; at *p*H 6 it is about − 0·2 v. but is poor in shape. The step becomes more negative and improves in shape as the solution is made more alkaline.

It may be noted that no maxima have been observed in any of the solutions containing triethanolamine, consequently a suppressing agent is not needed.

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Cambridge Instrument Co., Ltd.,
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June 3.

[1] Wolfson, H., *Nature*, **153**, 375 (1944).
[2] Kolthoff and Lingane, "Polarography" (Interscience Publishers, Inc., 1941).

State of Vitamin A in Human Serum

Chromatographic separation on alumina was applied to the separate estimation of vitamin A alcohol and its esters in extracts from human serum. It was found in eleven normal subjects that 10–17 per cent of the total vitamin A is present in the form of esters.

Three conditions were studied in which the vitamin A level is known to be temporarily raised. The rises which occurred as a consequence of endogenous mobilization of vitamin A, as after delivery[1] and after drinking alcohol[2], were found to be due to a rise in the vitamin A alcohol. On the other hand, oral administration of vitamin A, ester or alcohol, resulted in a rise of the ester fraction only.

Experimental details will be published elsewhere.

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[1] Abt, A. F., Aron, H. C. S., Bundesen, H. N., Delaney, M. A., Farmer, C. J., Greenebaum, R. S., Wenger, O. C., and White, J. L., *Quart. Bull. Northw. Univ. Med. School*, **16**, 245 (1943).
[2] Clausen, S. W., Breese, B. B., Baum, W. S., McCoord, A. B., and Ryddeen, J. O., *Science*, **93**, 21 (1941).

Biological Activity of Vitamin A Acid

In a previous communication in *Nature*[1], we reported that the amount of vitamin A acid equivalent to one international unit of vitamin A (0·3 γ pure crystalline vitamin A or 0·6 γ pure β-carotene) is dependent on the method of administration. In the growth-test with *A*-deficient rats, using a β-carotene standard in oily solution (orally) for comparison, the equivalents were as follows: (1) free vitamin A acid, dissolved in peanut oil and given orally, 1 I.U. equal to 4·0 γ; (2) sodium salt of crystalline vitamin A acid, dissolved in buffer solution (pH 10·0) and injected subcutaneously, 1 I.U. equal to 0·6 γ.

We have now found that the sodium salt, dissolved in buffer (pH 10·0) and given orally, is still more potent, 1 I.U. being equal to 0·3 γ. Hence the sodium salt of vitamin A acid given orally in aqueous solution seems to be as potent as vitamin A itself given orally in oil.

The experiments were carried out with groups of 8–13 rats for each concentration of β-carotene and vitamin A acid.

We are now studying the question whether vitamin A acid is converted to vitamin A in the animal body, or acts as such.

Full details about the above experiments, which were carried out in collaboration with Dr. A. Mennega and Mr. R. W. Spanhoff, of the Pharmacological Department here, will be published elsewhere.

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[1] *Nature*, **157**, 190 (1946).

Electrolytic Reduction in Liquid Ammonia

Benzenoid compounds have been reduced to dihydro-derivatives by means of sodium and alcohol in liquid ammonia[1]. The process has now been carried out electrolytically on *m*-tolyl methyl ether at a smooth copper cathode with a current density of 0·04 amp./sq. cm. in a saturated solution of sodium ethoxide in liquid ammonia containing 5 per cent of ethyl alcohol, the temperature being maintained at about − 40° by means of a solid carbon dioxide – alcohol bath. The dihydro-*m*-tolyl methyl ether, probably the 2 : 5-, was identified (see ref. 1) by conversion to the 2 : 4-dinitrophenyl-hydrazone of 3-methyl-Δ^2-*cyclo*hexenone, m.p. 174°, undepressed by an authentic specimen. The current efficiency of the reduction was low, but can probably be improved, and the process may be of general utility for similar reactions.

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June 7.

[1] Birch, *J. Chem Soc.*, 430 (1944).

Hydrocarbon Azeotropes of Benzene

In a recent publication[1], many of the binary, hydrocarbon azeotropes of benzene have been described, and it has been shown how the properties of such azeotropes may be correlated with the properties of the non-benzene component. On the basis of this correlation, the occurrence and properties of certain unknown benzene azeotropes have been predicted.

It is therefore of interest that work recently carried out in these laboratories on vapour-liquid equilibrium at atmospheric pressure enables an experimental check to be made upon the accuracy of one of these predictions, and provides further experimental evidence in one instance of conflicting published data. We have found that a minimum boiling azeotrope is formed in the system benzene − 2·2-dimethylpentane, of properties similar to those predicted, as shown in the accompanying table.

In the system benzene − 2.4-dimethylpentane there is some discrepancy between the results of Marschner and Cropper[1] and those of Richards and Hargreaves[2], and in the accompanying table it is shown that our results are in close agreement with those of the former authors.

Marschner and Cropper[1] propose azeotropic distillation with benzene as a means of separating close-boiling paraffin-*cyclo*-paraffin (naphthene) mixtures. This technique, however, has already[3] been discovered and successfully applied in these laboratories to the separation of cyclohexane from 2.2- and 2.4-dimethylpentanes, which is the most difficult step in the recovery of pure cyclohexane from Iranian petroleum distillates.

Our vapour-liquid equilibrium data were obtained using fractionating columns equivalent to 100-theoretical plates and Othmer-type equilibrium stills[4], all temperatures being recorded electrically to within 0·05° C.

Components of azeotrope	Properties of azeotrope		Reference
	b.p. at 760 mm. (° C.)	Mol. per cent benzene	
Benzene- 2.2-dimethylpentane	75·7 75·85	48 52·5	Predicted values[1] This work
Benzene- 2.4-dimethylpentane	76·7 76·6 75·3* 76·45	56·2 56·7 54·5 56·4	ref. 1 ref. 1 ref. 3 This work

* Estimated from the literature value of 75·2° C. at 757 mm.

Our thanks are due to the chairman of the Anglo-Iranian Oil Co., Ltd., for permission to publish these results.

S. F. Birch
C. B. Collis
R. A. Lowry

Anglo-Iranian Oil Co., Ltd.,
Research Station, Sunbury-on-Thames,
Middlesex. May 24.

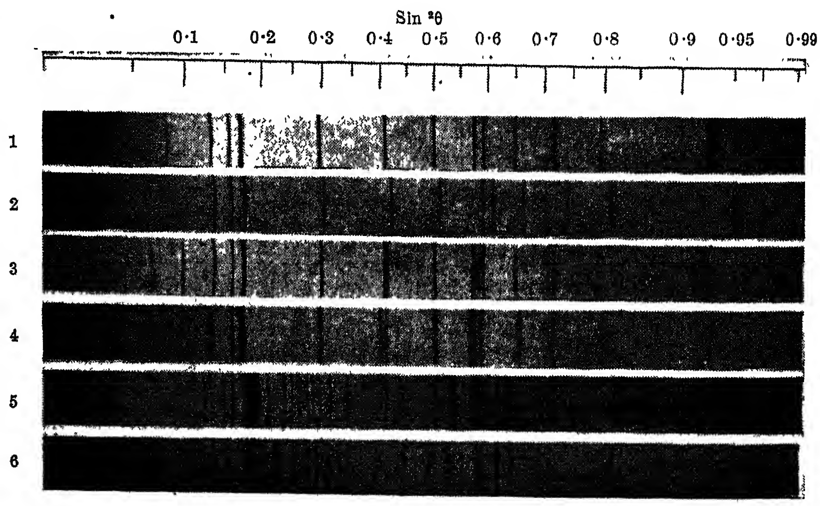
[1] Marschner and Cropper, *Ind. Eng. Chem.*, **38**, 262 (1946).
[2] Richards and Hargreaves, *Ind. Eng. Chem.*, **36**, 805 (1944).
[3] Birch, Habeshaw and Collis, Brit. Prov. Patent Application 24302/44, filed Dec. 5, 1944.
[4] Othmer, *Ind. Eng. Chem.*, **35**, 614 (1943).

Iron-Nitrogen, Iron-Carbon and Iron-Carbon-Nitrogen Interstitial Alloys: their Occurrence in Tempered Martensite

In a recent communication[1], Heidenreich, Sturkey and Woods report that when martensitic steel is tempered at 200° C. a fine dispersion of hexagonal Fe_3N is produced with no trace of cementite. Above 300° C. the reaction product is cementite; further, Fe_3N formed at 200° C. is transformed to cementite by heating at 350° C. The presence of an unknown carbide is reported by Arbusow and Kurdjumow[2] when martensite is tempered at 130–300° C.; above 300° C. this carbide decomposes into cementite.

Investigations of the iron-nitrogen, iron-carbon and iron-carbon-nitrogen systems, carried out during the last two years for the British Iron and Steel Research Association, have provided a simple explanation for the above observations. The results, which will be given in detail elsewhere, may be summarized as follows.

Iron-nitrogen system. The existence of the ζ-iron nitride phase[3] (N, 11·1–11·3 wt. per cent) is confirmed. It is prepared by passing anhydrous ammonia over ε-iron nitrides (N, 7·3–11·0 per cent) or over pure iron at temperatures below 450° C. under such conditions that the partial pressure of hydrogen is negligible. The ε-phase has a 'normal' 12*b*6 structure and the ζ-phase a distorted 12*b*6 structure[4], but the arrangement of nitrogen atoms, deduced from observations of numerous faint superlattice reflexions on X-ray powder photographs, is different in each of these phases. In the ε-phase, when the composition corresponds to Fe_3N, one third of the octahedral interstices in the iron atom lattice are occupied by nitrogen atoms in such a way that each nitrogen atom has the nearest six interstices surrounding it in its own layer plane unoccupied, and interstices directly above it in the next two planes also unoccupied. As the nitrogen concentration increases, the additional nitrogen atoms occupy empty interstices in



1. ε-Iron nitride. N, 32·1 atomic per cent
2. ε-Iron carbonitride. C, 15·7; N, 13·0 atomic per cent
3. ζ-Iron nitride. N, 33·7 atomic per cent
4. ζ-Iron carbonitride. C, 23·8; N, 10·8 atomic per cent
5. Iron percarbide. C, 32·1 atomic per cent
6. Cementite (Fe_3C), small amount of graphitic carbon

a random manner until the composition approaches that of Fe_2N. At this point, rearrangement of nitrogen atoms occurs until they are once more completely ordered, each occupied interstice having an unoccupied 'hole' directly above and below it. The anisotropic distortion of the ε-hexagonal lattice of iron atoms to give the base-centred orthorhombic lattice of the ζ-phase is explained by, and is a result of, this rearrangement of nitrogen atoms; in the ε-phase the nitrogen atoms of each layer plane are uniformly distributed, but in the ζ-phase they are packed more closely in the direction of the b-axis than in that of the a-axis, resulting in b becoming greater than $\sqrt{3}.a$.

Iron-carbon-nitrogen system. By the action of carbon monoxide on iron nitrides below 500° C., nitrogen is gradually replaced by carbon with the formation of *iron carbonitrides*—a series of new ternary interstitial compounds containing iron, carbon and nitrogen. *ζ-phase carbonitrides* have a range of homogeneity 33·3–36·0 atomic per cent nitrogen plus carbon, extending approximately from Fe_2N_4 to Fe_2C_3N, with a maximum carbon concentration *c.* 25 atomic per cent. They have distorted 'normal' 12b6 structures essentially the same as those of ζ-iron nitrides, except that distortion increases with increasing carbon concentration. This distortion is explained by a gradual rearrangement of interstitial atoms, within the approximately close-packed iron atom lattice, from the superlattice structure shown by ε-nitrides to the type shown by ζ-iron nitrides. Annealing of ζ-carbonitrides and reaction of ammonia with iron carbides give *ε-phase carbonitrides*, which have 12b6 structures identical with those of ε-iron nitrides, and a homogeneity range 25–33 atomic per cent nitrogen plus carbon.

ζ-carbonitrides start to decompose slowly *in vacuo* at about 350° C., eliminating nitrogen and giving ε-carbonitrides; these in turn are unstable at 450° C. and decompose to give, according to their nitrogen and carbon contents, γ'- or ε-nitrides and either *iron percarbide* or cementite.

Iron-carbon system. Prolonged reaction of carbon monoxide with iron nitrides below 500° C. results in complete elimination of nitrogen and formation of *iron percarbide*; this has a small range of composition, C, 30·5–32·1 atomic per cent, and is identical with an unknown carbide obtained previously by Hägg[5] and assumed to be Fe_2C. It is now found that the unit cell is probably orthorhombic, with dimensions

$$a,\ 9{\cdot}04(3);\ b,\ \sqrt{3}.a = 15{\cdot}66(3);\ c,\ 7{\cdot}92(1)\ \text{kX.},$$

and contains four $Fe_{20}C_9$ molecules.

Above 500° C., the product of the same reaction is cementite, which is identical with specimens formed below 700° C. in steel[6] and obtained by the action of carbon monoxide on ferric oxide[7].

Both iron carbides appear to be metastable; iron percarbide decomposes *in vacuo* giving cementite and carbon, and cementite breaks down less rapidly to give α-iron and carbon. Below about 350° C. rates of decomposition are negligible.

Examples of X-ray powder photographs (cobalt $K\alpha$ radiation; 19-cm. diameter camera) of iron nitrides, carbonitrides and carbides are reproduced herewith.

It is obvious that the hexagonal phase reported by Heidenreich *et al.*[1] as "Fe_3N" is an ε-carbonitride. In steel, the presence of other elements or of large excess of iron may reduce the decomposition temperature of this phase from 450° C. to 350° C. Probable reactions in the tempering of martensite are thus:

$$\text{(1)}\quad \overbrace{\text{Fe} + \text{C(interstitial)} + \text{N(interstitial)}}^{\text{Martensite}} \xrightarrow{200^\circ\text{ C.}} \varepsilon\text{-carbonitride}$$

$$\text{(2)}\quad \varepsilon\text{-carbonitride} \xrightarrow{<300^\circ\text{ C.}} \text{iron percarbide} + \text{N(dissolved in } \alpha\text{-Fe)}$$

$$\text{(3)}\quad \varepsilon\text{-carbonitride} \xrightarrow{400^\circ\text{ C.}} \text{cementite} + \text{N(dissolved in } \alpha\text{-Fe)}.$$

Preliminary experiments indicate that in carburizing mild steel at 750° C., with carbon monoxide, the penetration of carbon is greatly facilitated by previously nitriding the surface; reactions similar to those described above occur. It is very probable that carbonitrides are also formed in the case-hardening of steel by the dry-cyaniding process.

K. H. JACK

Department of Chemistry, King's College,
Newcastle-upon-Tyne, 1. June 12.

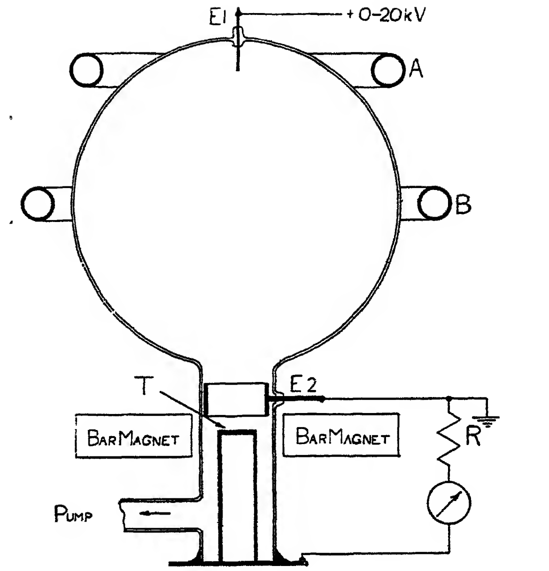
[1] Heidenreich, Sturkey and Woods, *Nature*, **157**, 518 (1946).
[2] Arbusow and Kurdjumow, *J. Phys. U.S.S.R.*, **5**, 101 (1941).
[3] Hägg, *Nova Acta Reg. Soc. Sci. Upsaliensis*, iv, **7**, 1 (1929).
[4] Hägg, *Z. physikal. Chem.*, B, **12**, 33 (1931).
[5] Hägg, *Z. Krist.*, **89**, 92 (1934).
[6] Petch, *J. Iron Steel Inst.*, **149**, 143 (1944).
[7] Taylor, J., unpublished work. Lipson and Petch, *J. Iron and Steel Inst.*, **142**, 95 (1940).

High-frequency Discharge as an Ion Source

It has been found possible to draw a 10-milliampere current of positive hydrogen ions from a high-frequency discharge maintained at a pressure of about 10^{-3} mm. A self-sustained discharge cannot be maintained at this pressure with constant potentials even up to 20 kilovolts, and it is thus possible to use constant potentials of this order to extract positive ions from the discharge and to focus them into a beam. The arrangement is shown in the accompanying diagram.

The discharge was maintained in a two-litre 'Pyrex' flask by two ring electrodes A and B excited by a 5-metre oscillator. Approximately 200 watts could be dissipated in the bulb. The ionized gas was held at a high potential (between 0 and 20 kV.) by means of the electrode E_1. The ions were drawn out of the discharge by the hollow cylindrical electrode E_2 held at earth potential.

As the high tension was increased from zero the discharge, which initially projected a small distance into the neck of the flask, retreated from the neck until at 20 kV. the dark space was about 5 cm. deep. The boundary of the dark space resembled a spherical cap with the



centre near the copper target T. A luminous red cone with its apex on the target and its base on the discharge boundary indicated the envelope of the ion beam. The fluorescent spot on the target was estimated visually to be about 2 mm. in diameter. The distance between the beam focus and the target increased as the high tension was increased.

In order to prevent the influence of secondary electrons on the target current, the target potential was maintained at about 700 volts higher than that of E_2 by means of the resistance R. In addition, two Alnico bar magnets near the target produced a strong magnetic field parallel to its surface.

The ion current to the target increased from 10 milliamperes at 10 kilovolts to 12 milliamperes at 20 kilovolts.

It is proposed to make a magnetic analysis of the beam and to see whether the ion currents can be increased by the use of a magnetic field.

P. C. THONEMANN

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University of Sydney. May 27.

A Particle-size Distribution Function for Air-borne Dusts

The following function has been found useful in problems involving the sedimentation or transport of air-borne bacteria-carrying dusts in inhabited rooms.

$$Y_S = CS^n \exp - \alpha S, \quad . \quad . \quad . \quad (1)$$

where S is the settling-rate of a particle in still air (proportional to the square of the diameter (d) for spheres obeying Stokes's law), Y_S is the frequency of occurrence of particles with settling-rate S, C is a normalizing coefficient ($C = 100\ \frac{\alpha^{n+1}}{\Gamma(n+1)}$ for a total of 100 particles) and n and α are constants.

For values of n greater than zero, this leads to a skew distribution with Y_0 zero. The mean value of S is given by $(n+1)/\alpha$ and the modal value by n/α.

The equation may be rewritten in terms of the fraction, S', of the modal value as

$$Y_S' = C' \,.\, S'^n.\ \exp - nS', \quad . \quad . \quad (2)$$

from which it is clear that the constant α represents a scale factor only while the 'spread' of the distribution is determined by the value of n.

This distribution has the important property of persisting without change of form during sedimentation of the dust from a continuously mixed atmosphere (that is, an atmosphere in which turbulence is sufficient to maintain a uniform distribution of particles, but the air velocities are not so high as to redisperse sedimented material). For after a time t,

$$Y_S = CS^n \exp - \alpha S \exp - bSt,$$

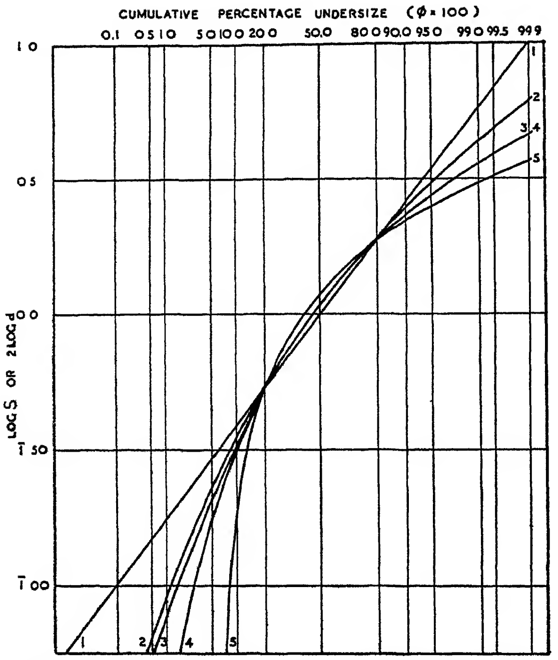
where b is a constant (equal to A/V when sedimentation is taking place in a room of volume V on to surfaces of area A). Hence

$$Y_S = CS^n \exp - (\alpha + bt)S,$$

and the distribution is altered only in the value of the constant α.

There will, then, be a tendency for any suspended material to approximate to this form of distribution as sedimentation proceeds (within the limitation of the original particle-size distribution of the material).

The accompanying graph shows a number of distribution functions plotted as cumulative percentage under size on logarithmic probability paper. It will be seen that the distribution discussed here lies between the logarithmic probability function (the divergence from the logarithmic probability function becomes less as n increases, being only



CURVE 1. LOGARITHMIC PROBABILITY (LOGNORMAL DISTRIBUTION).
CURVE 2. EQUATION (1), $n = 1$.
CURVE 3. ROSIN–RAMMLER RELATION IN S OR d:

$$\varphi = 1 - \exp\left(-\left(\frac{S}{a}\right)^{b}\right).$$

CURVE 4. ARITHMETIC PROBABILITY (NORMAL OR GAUSSIAN DISTRIBUTION) IN d.
CURVE 5. ARITHMETIC PROBABILITY (NORMAL OR GAUSSIAN DISTRIBUTION) IN S.

about one half as great for $n = 4$ as for $n = 1$) and the Rosin–Rammle. function, and it may be interesting to quote from the paper by C. Er Lapple[1], from which this figure is partly taken: "Usually distributions obtained in practice will yield curves that are intermediate between the log probability and Rosin–Rammler relationships, probably nearer the latter. . . ."

The general integrated form of equation (1) is not obtainable except for integral values of n, but the particular integral $\int_0^\infty Y_S.dS$ and many derivatives of this which appear in sedimentation and dust-transport problems are easily evaluated.

An important limitation of the function is that there is a relatively low upper limit to the degree of dispersion, roughly equivalent to a standard deviation of 0·4 on the closest logarithmic probability distribution. The range is, however, wide enough to cover a considerable number of cases, especially where the material remains in suspension for any considerable time.

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June 6.

[1] Lapple, C. E., *Heating, Piping and Air Conditioning*, 18, 113 (1946).

The Lorentz Transformation

IN a letter entitled "A Simple Proof of the Lorentz Transformation" appearing in *Nature*[1], an error has been introduced into the matrix algebra, the correction of which requires a certain recasting of the proof.

From postulate ($P1$), it follows that

$$f_{11}(-v) = \frac{f_{22}(v)}{D(v)},\ f_{12}(-v) = -\frac{f_{12}(v)}{D(v)},$$

$$f_{21}(-v) = -\frac{f_{21}(v)}{D(v)},\ f_{22}(-v) = \frac{f_{11}(v)}{D(v)} \quad (1,2,3,4)$$

By writing $-v$ for v in (2), (3), or (1) and (4), it may be seen that $D(v)\,D(-v) = 1$. On the other hand, the author's derivation of the relationship $D(v) = D(-v) = 1$, obtained by constructing the determinant $D(-v)$, cannot be accepted since

$$D(-v) = \frac{1}{(D(v))^2}\begin{vmatrix} f_{22}(v) & \mp f_{12}(v) \\ -f_{21}(v) & f_{11}(v)\end{vmatrix} = \frac{1}{D(v)},$$

which has already been proved.

The proof of the Lorentz transformation may be continued as follows:

From postulate ($P2$), it follows that $\frac{f_{12}(v)}{f_{21}(v)}$ and $\frac{f_{11}(v) - f_{22}(v)}{f_{12}(v)}$ are invariant and we write $\frac{f_{12}(v)}{f_{21}(v)} = C^2$. By definition $v = -\frac{f_{12}(v)}{f_{11}(v)}$.

$$\therefore\quad D(v) = f_{11}(v)\ \left(f_{22}(v) - \frac{v^2}{c^2}\, f_{11}(v)\right)$$

and $D(-v) = f_{11}(-v)\left(f_{22}(-v) - \frac{v^2}{c^2}\, f_{11}(-v)\right)$

$$= \frac{f_{22}(v)}{(D(v))^2}\ \left(f_{11}(v) - \frac{v^2}{c^2}\, f_{22}(v)\right).$$

From this it follows that $f_{22}(v) = \pm f_{11}(v)$.

Now if $f_{22}(v) = -f_{11}(v)$, $\frac{f_{11}(v) - f_{22}(v)}{f_{12}(v)} = -\frac{2}{v}$, which contradicts ($P2$).

$\therefore f_{22}(v) = f_{11}(v)$, and further, $f_{11}(v) f_{11}(-v) = \frac{1}{1 - v^2/c^2}$.

$$\therefore\ F(v) = f_{11}(v)\begin{bmatrix} 1 & -v \\ -v/c^2 & 1\end{bmatrix}, \quad . \ . \quad (3)$$

$$\text{and } f_{11}(v)\, f_{11}(-v) = \frac{1}{1 - v^2/c^2}, \quad . \ . \quad (3a_c)$$

$$\left(\text{thus } f_{11}(v) = \frac{\lambda^v}{\sqrt{1 - v^2/c^2}} \text{ satisfies } (3a_c)\right).$$

To complete the proof it is evidently necessary to introduce a further postulate, and it would therefore appear that the conclusion drawn in the original letter, namely, that the Lorentz transformation has a more general significance than is widely believed, requires further examination.

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June 6.

[1] Strauss, M. D. H., *Nature*, 157, 516 (1946).

THE derivation of the Lorentz transformation, as given in my previous communication, is marred by a mistake, pointed out by Mr. P. J. Hilton, which I wish to correct.

The two postulates for the transformation matrix, namely,

$$F(-v) = F(v)^{-1}, \quad . \ . \ . \quad (P1)$$

$$F(v)\,F(v') = F(v')\,F(v), \quad . \ . \ . \quad (P2)$$

together with the definition of v, lead to

$$F(v) = f_{11}(v)\begin{pmatrix} 1 & -v \\ -v/C^2 & 1\end{pmatrix}. \quad . \ . \quad (3)$$

with

$$f_{11}(v)\, f_{11}(-v) = [1 - v^2/C^2]^{-1}. \quad . \quad (3a_c)$$

If we now assume the space to be isotropic, the equations

$$x' = f_{11}(v)\ x + f_{12}(v)\ t, \quad . \ . \ . \quad (1a)$$

$$t' = f_{21}(v)\ x + f_{22}(v)\ t, \quad . \ . \ . \quad (1b)$$

must be invariant under the substitution

$$x \to -x, \quad x' \to -x', \quad v \to -v,$$

so that

$$f_{11}(v) = f_{11}(-v), \quad . \ . \ . \ . \quad (P3)$$

which together with $(3a_c)$ gives the desired result.

It may be worth noting that ($P3$) is not required to establish the group property of the transformations $F(v)$ and the formula for the composition of velocities; both follow from (3) and the definition of v.

It would therefore appear that the conclusion drawn in my previous letter is essentially correct. I should also like to point out that the traditional method of using, in addition to the postulate of relativity, the postulate of the constancy of the velocity of light, was perfectly rational at a time when the two postulates were thought to contradict each other. Yet when one learns afterwards that the Galilean transformation follows from the Lorentz transformation by the specification $C = \infty$, one naturally wonders why it should be necessary to invoke a postulate which leaves no trace in the result. The answer, as we have seen, is that no such postulate is required.

In the meantime, I have learned to my satisfaction that other authors have come to the same conclusion. Pars[1] has derived the Lorentz transformation from the postulates that the space is isotropic and that the transformations $F(v)$ form a group. Frank and Rothe[2] have treated the problem in a somewhat more general way with similar results.

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Woolwich Polytechnic,
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May 22.

[1] *Phil. Mag.*, 42 (1921).
[2] *Ann. Phys.*, 34 (1911).

Change of Frequency of a Light Wave by the Variation of its Optical Path

THE time t' at which B receives the wave sent from A at time t is related to t by

$$t' = t + \frac{\Sigma\mu l}{c},$$

where c/μ is the velocity of the wave in a medium of refractive index μ and length l through which the wave travels.

Therefore,

$$dt' = dt + \frac{d}{dt}\left(\frac{\Sigma\mu l}{c}\right)dt,$$

or the frequency,

$$\nu' = \frac{\nu_0 dt}{dt'} = \frac{\nu_0}{1 + \frac{d}{dt}\left(\frac{\Sigma\mu l}{c}\right)} \doteq \nu_0\left(1 - \frac{d}{dt}\frac{\Sigma\mu l}{c}\right), \quad (1)$$

where ν_0 is the original frequency.

The change of frequency can be obtained either through the rate of change of μ or through the rate of change of l. The latter is identical with the Doppler effect if $\mu = 1$. Thus, in any interference experiment of light, the motion of interference fringes by changing the optical path of one of the two interference beams is equivalent to light-beats. The changes of frequency of the diffracted and the directly transmitted light by a progressive ultra-sonic wave might be better understood by considering relation (1).

Relation (1), when applied to material waves, gives interesting confirmation of the relation $E = h\nu$.

Careful considerations show that relation (1) represents only one kind of change of energy of photons, this being of the work done against a force due to the rate of changing linear momentum of photons. The general principle of the change of frequency of a wave should be expressed as:

$$\nu' - \nu_0 = -\frac{1}{2\pi}\frac{d\Phi}{dt}, \quad . \quad . \quad . \quad (2)$$

where $\frac{d\Phi}{dt}$ is the rate of change of the phase of the wave.

By applying this general principle, another important case of the change of frequency of the light wave, namely, the change of frequency due to the rotation of a doubly refractive medium through which the light passes, can be explained. On resolving analytically the emergent waves into circularly polarized components and examining the variation of phase in each component, the changes of frequency are readily shown to be 0, $-2N$ and $+2N$, N being the number of rotations per second. The relative amounts of light having these respective frequency changes depend on the length of light-path in the medium, the state of polarization of the incident light and the angles which the axis of rotation makes with the optical axis and the direction of the incident light. This case represents the second kind of change of energy of photons, and relates to work done against a torque exerted on the medium by the turned-over photons as defined by Atkinson[1].

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[1] Atkinson, *Phys. Rev.*, **47**, 623 (1935).

Seismic Sea-Wave of November 27, 1945

THE Chief Meteorological Officer, Royal Air Force, East Africa, has reported an interesting tidal irregularity observed by Captain A. Sauvage, port officer at Port Victoria, Mahé, Seychelles, on November 28, 1945, at about 10 a.m. local time. It appears that while the normal water-level corresponding with the state of tide at this time was 1·5 in., the level observed at 9 hr. 47 min. a.m. was 12 in. The water then rose to 18 in. at 9 hr. 52 min., dropped to 0 at 10 hr. 5 min. and rose again to 14·5 in. at 10 hr. 13 min. a.m.

This tidal irregularity was almost certainly associated with the major earthquake which occurred some hours earlier in the Arabian Sea[1]. The seismograph records at Kew Observatory, Richmond, showed the first pulse for this earthquake on November 27, 1945, at 22 hr. 6 min. 22 sec. G.M.T., the maximum phase at 22 hr. 40 min. 45 sec. (ground movement at Richmond nearly 2 mm.), and the end at 2 hr. 30 min. on November 28. The analysis of the Kew Observatory records gave a distance of about 6 100 km., and the combination of the results from other seismological stations determined the epicentre as at lat. 25° N. and long. 62·2° E., with a time of origin at 21 hr. 57 min. 0 sec. G.M.T. This is 7 hr. 55 min. before the first peak (5 hr. 52 min. G.M.T.) of the 'tidal wave' was observed at the Seychelles.

As the distance of Mahé from the epicentre is 3,300 km., this gives an average speed v of the sea-wave of about 116 m./sec. and from this we can calculate the average depth H of ocean traversed to be about 1·3 km. If the peak of the tidal wave observed at 10 hr. 13 min. is taken as representing the second crest of the seismic sea-wave, the time interval of 21 min. between the two crests leads to a wave-length for this wave of $L = 146$ km.

Those values of v, H and L are substantially smaller than the values deduced from other recorded cases of seismic sea-waves. Gutenberg[2] gives four cases where $v = 169$–208 m./sec., and refers to $L = 150$–500 km. as typical wave-lengths.

Now the estimate from eight approximately equidistant soundings gives the actual depth of ocean traversed as about 3·5 km., and, reversing the procedure, this leads to a speed of the seismic sea-wave of 187 m./sec. With this speed the wave would travel the 3,300 km. to the Seychelles in 4 hr. 53 min., so that on this basis of reckoning the first wave should have arrived at 2 hr. 50 min. G.M.T. (6 hr. 50 min local time) on November 28. The first tidal observation was made at 9 hr. 47 min. local time, but it was then noted that tidal-levels were well above their normal value, suggesting that an earlier wave may indeed have arrived by that time.

Using the 21-min. interval between the two observed crests and the 9-cm. decrease in amplitude, we may conclude that the first observed crest was the eighth in the train, and that the first crest arrived with an amplitude of about 0·7 m. above normal. This agrees well with the order of magnitude given by Gutenberg[3] for large seismic waves in the open sea. Both the velocity (187 m./sec.) and the corresponding wave-length (236 km.) are also well within the range of values quoted above for similar phenomena.

Remembering that about 100,000 seismic disturbances are experienced every year, it is of interest to add that the earthquake which caused this tidal wave was among the twelve most violent shocks experienced in the past forty years[4]. It was of the same order of magnitude as the earthquake which destroyed San Francisco on April 18, 1906. The same communication by Rothé directs attention to the fact that E. Suess in 1883 postulated a large sea-wave originating in about the same region as the earthquake of November 28, 1945, as being responsible for the Deluge. This notion was sceptically received, because there was no observational evidence of any seismic sea-waves ever having occurred in this region.

We are indebted to the Director of the Meteorological Office for permission to communicate this note.

ARTHUR BEER
J. M. STAGG

Kew Observatory,
Richmond, Surrey.
June 4.

[1] *Nature*, **156**, 712 (1945).
[2] "Handb. d. Geophysik", **4**, 668 (1932).
[3] *l.c.*, p. 667.
[4] Rothé, J. P., *C R. Acad. Sci. Paris*, **222**, 301 (1946).

Japanese Men of Science in Malaya during Japanese Occupation

THE circumstances of the publication of C. F. Symington's "Foresters' Manual of Dipterocarps", recently reviewed in *Nature*[1], are known to very few persons, but they are interesting enough to be recorded in detail. The Manual was issued from Raffles' Museum, Singapore (Syonan Hakubutukan), towards the end of 1943 and was on sale solely for *bona fide* men of science. At that time, the Japanese Military Administration and the Syonan (Singapore) Municipality were endeavouring harder than ever to stamp out all traces of the British, even their language. That the Manual was published, and that there was a stock of some 280 copies for the British in September 1945, we owe to the far-sightedness, influence and discretion of a few Japanese men of science.

The acting director at Raffles' Museum in 1942 was Prof. Hidezo Tanakadate, of Tohoku Imperial University, Sendai. He obtained the temporary release of Mr. H. E. Desch, of the Malayan Forestry Service, from the Changi Military Camp and, at the end of June, took Mr. Desch to Kuala Lumpur, where he found the galley-proof of the Manual. It was decided to publish the work (500 copies) on the ground that it would be more likely to survive the War in that way than as a single galley-proof, for the whereabouts of Mr. Symington and his manuscript were unknown. The cost of printing was met personally by Prof. Tanakadate and by Marquis Yositika Tokugawa, who acted as president of the Museum and Library. It was insisted by Prof. Tanakadate that the book should conform exactly with the previous series of *Malayan Forest Records*, of which it is No. 16, so that it should stand the test of time, as a scientific work, regardless of hostilities and racial prejudice. He therefore added a brief preface, as a single page of romanized Japanese, and he issued the Manual from the Museum to give it official standing and to prevent pilfering of the stock by what he called 'common people'.

The proofs were read mainly by Mr. Desch, even after his return to the Military Camp in January 1943. The Japanese officers who succeeded Prof. Tanakadate, namely, Prof. Kwan Koriba and Dr. Y. Haneda, took the proofs personally to the camp and fetched them again on correction. As the printing was continued by the Caxton Press in Kuala Lumpur, great care had to be taken in sending the proofs from Singapore, for there was a very strict censorship and the post was unreliable. Japanese staff officers travelling to and fro carried them personally, while duplicates were kept at the Singapore Botanic Gardens. The co-operation of military officers was possible only because they were known personally to the professors as students or colleagues.

Similar action was taken by Dr. Koga, the director of the Tokyo Zoological Gardens, in publishing M. W. F Tweedie's "Poisonous Animals of Malaya", which was rescued from the broken and looted premises of the Methodist Publishing House in Singapore. A large remainder is also at Raffles' Museum.

In the interest of science, one must distinguish carefully between the 'Japanese' of popular conception and the Japanese men of science, who in Malaya, at least, endeavoured to serve science with impartiality.

E. J. H. CORNER

15 The Park,
Great Shelford,
Cambridge.
May 28.

[1] *Nature*, **157**, 671 (1946).

RESEARCH ITEMS

Insect Transmission of Beet Mosaic and Beet Yellows

THE intimate relations which exist between a virus and its insect vector are gradually becoming amenable to classification. M. A. Watson (*Proc. Roy. Soc.*, B, 133, 200; 1946) has recently added two more studies of virus-insect relations to our present knowledge. Vectors of beet mosaic virus are optimally infective after feeding for only a few minutes upon infected plants, after preliminary fasting. Infection is quickly lost thereafter, when aphids are fed upon healthy plants. Beet mosaic virus is an example of a group of viruses which are non-persistent in their insect vectors. Other members of the group have generally similar physical properties to beet mosaic virus. Beet yellows belongs to a group of viruses which persist in the insect vector. Its infectivity is not affected by preliminary fasting, and increases with increased feeding time on both infected and healthy plants. The difference between persistent and non-persistent viruses now appears to be that the latter are taken up more readily by an insect after preliminary fasting, whereas the latter are not. The aphid *Myzus persicæ* was used as vector for both viruses, thus showing that the differences in behaviour are properties of the viruses themselves. Some success has been attained in separating the two viruses from the same host by differential feeding methods of the same vector.

Nodule Bacteria of Legumes

TWENTY-TWO cross-inoculation groups of leguminous bacteria are now known, and in a review of twenty-eight papers, J. K. Wilson (*Cornell Univ. Agric. Exp. Sta.*, Mem. 267; 1945) summarizes the data concerning the reciprocal relations of the nodule bacteria of the cowpea and the soya bean. A detailed analysis of twelve isolates from soya bean showed that none was specific for this host, and twenty-four species of *Crotalaria* formed nodules with one or more of the isolates. There is evidence of variation of bacteria from a single plant, which makes difficult the clear delineation of cross-inoculation groups.

Gene Action

S. G. STEPHENS (*J. Gen.*, 46, 331 and 345; 1945) considers the genetics and development of various leaf shapes in *Gossypium*. These are mainly controlled by a multiple allelomorphic series of genes. The author shows that the leaf character is also affected by other genes. Among these is one which controls the time of flowering. When a leaf-shape is transferred from a late to an early flowering species, the action of the gene is accelerated, but the duration of the development is reduced. Since these two influences are not correlated, a change in the leaf characters can occur. Intergradation of leaf shapes in species crosses may result from the transgressive segregation of the rate of development. The author points out that modifiers or minor genes for a particular character may be a major gene as regards another character. Further, in the absence of a knowledge of the physiological processes controlled by the genes, there is no *a priori* reason to suppose that modifiers have minor effects. The five genes for leaf shape appear to control a canalized system lying in five developmental tracks which may be modified by the environment or by genetical modifiers. The alterations in shape are due to differences in time and rates of development. The author points out that, in regard to dominance, it would appear that the general cell activity and development controlled by the allelomorph rather than the activity of the allelomorph itself determine the dominance observed. Regarding non-adaptive trends of evolution, the author suggests, as D'Arcy Thompson does, that where cell-growth is involved, a canalized system of development will be involved which will be largely influenced by timing rates of development.

Cytogenetics of *Rosa canina*

A. GUSTAFSSON (*Hereditas*, 30, 407; 1944) confirms by the more satisfactory genetical evidence that the dog-rose is not apomictic and that fertilization is heterogamous. It will be remembered that Blackburn and Harrison, Gustafsson and Hakansson had shown by cytological methods that the egg with 28 chromosomes was regularly fertilized by the pollen nucleus with seven chromosomes. When used as a female in hybrids with *R. rugosa* and *R. rubiginosa* the *F*1 plants are markedly heterogeneous, whereas when *R. canina* is used as a male on *R. rubiginosa* the hybrids are more uniform. Similarly the fertility of the *F*1 plants differs considerably in the reciprocal parental crosses. This is correlated with differences in the meiosis of these hybrids. The chromosome constitutions are suggested to be *R. canina, aa acd*; *R. rubiginosa, bbbcf*; and *R. rugosa, cc*. The author indicates the changes necessary in the taxonomy of the *Rosa canina* complex in the light of the cytogenetical evidence.

Sex Ratios

IT is sometimes difficult to assess the sex ratios in animals at an early stage. S. E. Smith (*J. Hered.*, 36, 195; 1945) has shown that the heteropycnotic phenomenon of sex chromosomes may be used in a Lepidopteran, *Archips*, to discover the sex ratio before the third instar of the larva. The sex chromosome of the female is deeply stained through the nuclear cycle, whereas that of the homozygous male is not so differentiated.

Mosaics in *Drosophila*

C. AUERBACH (*Proc. Roy. Soc. Edin.*, 52, B, 120; 1945), by chemically treating embryos, has produced a large number of single or twin spots of marked characters in *Drosophila melanogaster*. More than 40 per cent of the treated individuals showed these mosaic types. By several experiments the author shows that these spots result from somatic crossing over, and are not due to chromosome deletions or duplications.

Convulsions Produced in Frogs by Sudden Changes of Temperature

Miguel Ozorio de Almeida, H. Moussatché and M. Vianna Dias describe the effect of sudden changes of temperature upon frogs (*Rev. Brasil. Biol.*, 5, No. 1; April 1945). The frogs were placed in a glass cylinder of about 5 litres capacity, containing water and ice. After remaining for a period which was varied in the experiments, the animal was suddenly placed in a similar flask containing water at a temperature of 30°–35° C. When placed first in the cold water the frog attempts to escape but gradually becomes lethargic. After 20–30 minutes the animal is withdrawn and placed in the warm water; it displays the symptoms of an epileptic attack. While some of the frogs succumb to the effects an hour or two after

being placed in warm water, most of them survive and show no ill-effects from their experience. The partial or total destruction of the nervous system prevents the attacks which ordinarily result from the sudden change of temperature. The destruction of a portion of the central nervous system inhibits the attack in the parts that are not injured. A study of the effects of the destruction, unilateral or bilateral, of the labyrinths of the internal ear shows that the production of an attack is not inhibited, but there are numerous negative cases.

Tinea nigra

A. E. Area Leão, Amadeu Cury and J. Martins Ferreira Filho have given a historical review of *Tinea nigra* and described a new case (*Rev. Brasil. Biol.*, 5, No. 2; July 1945). A photograph shows the disease on the palm of the hand, where it starts as a few small spots scattered about or forming a few groups. These slowly increase and unite to form dark spots which are distributed irregularly on the palm. Two photographs (magnification 100 and 500) show the progress of the parasite. The new case which the authors discovered is described and illustrated with seven photographs, and there is a discussion regarding the causative fungus, which has been put in the genus *Cladosporium*. Attempts were made to reproduce the disease in human beings, rabbits, guinea pigs and rats, by transplanting portions of the skin, but the results were negative.

New Zealand Earthquakes during 1943

THE annual report, for the year 1943–44, of the Dominion Observatory, Wellington, New Zealand (Acting Director: Mr. R. C. Hayes), contains, among other things, an account of the seismic activity in New Zealand during 1943. Slight or moderate activity continued in the Wairarapa region with generally decreasing frequency. There were occasional rather strong shocks in that region in the early part of the year. Of special note was the unusual activity in the South Island, particularly in the south-western portion of the Island. Two shocks reached minor destructive intensity (VII on the Modified Mercalli Scale). One occurred on May 8, in the Lake Wanaka region, and the other on August 23 in the Arthur's Pass region. The shock on May 8 was apparently the most pronounced felt in Dunedin for many years. The intensity recorded there was IV–V on the Modified Mercalli Scale (equivalent to 5 on the Rossi–Forel Scale). Groups of small or moderate local shocks occurred in the Wairoa region in January and April, and in the Rotorua region in February. June was the quietest month of the year. The total number of earthquakes reported felt in 1943 was 176. Of these, 122 were felt in some part of the North Island and 57 in some part of the South Island. Only three shocks were felt in both Islands. The maximum intensity reported in the North Island was VI on the Modified Mercalli Scale, and in the South Island VII. The above figures are based on reports furnished by officials at post-offices, lighthouses and by several private observers.

Galactic Influence

BY converting some thousands of meteorological records from solar to sidereal time, the veteran Russian man of science, N. A. Morozov (born in 1854), has discovered evidence of a centre of powerful cosmic influence situated in the region of the constellation Argo Navis (R.A. 8–11 hr.). This discovery is supported by the curves of temperature, relative humidity of the atmosphere, velocity of evaporation, rainfall and magnetic and electrical phenomena. This galactic influence, in his opinion, has a very important influence on terrestrial climate. The presence of a body in this region of the galaxy is postulated, and from the consideration of certain cyclic phenomena it is suggested that this body has a period of revolution of 280 ± years (*Bull. Acad. Sci. URSS, Sér. géograph. géophys.*, 8, 63; 1944).

Mechanical Stresses in Transformer Windings

IN a paper read by E. Billig before the Institution of Electrical Engineers in London, the forces and stresses set up in transformer windings and their clamping structures under short-circuit conditions are considered in detail. Various arrangements of windings and tappings in large power transformers are described, and the points at which particularly high mechanical stresses occur in concentric windings are discussed. Axial forces between the top and bottom halves of each winding or between different windings are responsible for (*a*) bending stresses in turns near the ends or adjacent to gaps in the windings, (*b*) compressive stresses in the body of the winding, and (*c*) tensile and compressive stresses in the clamping gear. Radial forces produce tensile stresses in the outer winding and buckling stresses in the inner winding, these stresses being more pronounced in coils adjacent to the main leakage duct. The paper considers in some detail the excessive mechanical stresses which can be caused by internal electrical breakdowns, the mechanism of cumulative shrinkage, the loss in clamping pressure due to switching stresses and thermal cycles, and the danger of subsequent movement of the windings causing abrasion of the insulation and final electrical breakdown. A rule is given for determining the minimum clamping pressure that should be maintained within the windings.

Photoelectric Recording of Meteors

Sky and Telescope of October 1945 contains a short notice of a photo-electric apparatus, devised by Dr. C. W. Gartlein at Cornwell, and an associate, which automatically counts meteors and also records their duration and brightness. Two photocells in a balanced circuit are directed to different parts of the heavens, and are so synchronized that when one cell intercepts light which is brighter than that received by the other, a recording pen on the graph is set in motion. The apparatus was originally designed for aurora work, and it was used with success during the period of the August Perseids.

Radcliffe Observatory, Pretoria, 1939–44

A PAPER on occultations observed at the Radcliffe Observatory, Pretoria, during 1939–44 has been published (*Mon. Not. Roy. Astro. Soc.*, 105, 3; 1945). The occultations—in each case disappearance at the dark limb—were observed with the 4½-in. finder of the reflector, but when the altitude of the moon was less than 30°, the 3-in. altazimuth was used. Six of the earlier occultations were observed by the late E. G. Williams, and those in November and December 1943 by R. O. Redman, all the other observations and reductions being made by H. Knox-Shaw. Stars used in the Nautical Almanac are marked in Table 1 by an asterisk, and Innes's method of reduction was employed for the fainter stars and for all stars in 1943 and 1944.

RE-DEDICATION OF SCIENCE IN GERMANY

THE first victims of Nazi anti-Semitism in Germany were Jews or persons of Jewish descent in official positions, for example at the universities; with a small class of exceptions, they were dismissed by a decree issued within six weeks of Hitler's final accession to power. The great chemist Fritz Haber, director of the Kaiser Wilhelm Institut für Physikalische Chemie in Berlin-Dahlem, though by birth a Jew, did not himself fall under the decree, but a number of junior members of his staff did. Haber decided to resign in protest against this decree, and a few months later (in the summer of 1933) he left Germany. In his absence false accusations were levelled against him which rendered a return dangerous. He became an exile and died in exile on January 29, 1934 (see *Nature*, 133, 349; 1934).

Haber had been virtually the founder in 1912 of the Kaiser Wilhelm Institut für Physikalische Chemie, which he directed for twenty-one years. He also acted during this time as chief adviser to the president of the Kaiser Wilhelm Gesellschaft in the choice of candidates for senior appointments throughout the research institutes of the Society. Moreover, locally in Dahlem, the Institute under his direction was for a number of years the main centre of scientific discussions among the group of research institutes situated there. Haber's position was unsurpassed in Germany as an organiser of scientific life and thought.

Paying tribute to Haber's services, the Kaiser Wilhelm Gesellschaft and Haber's friends and pupils had planted in 1928 on Haber's sixtieth birthday a lime tree in front of the main entrance of his Institute, which was named the 'Haber Linde'. On the encircling stone parapet an inscription was engraved dedicating the tree to Fritz Haber. When a Nazi director took over the Institute, however, this visible tribute to Haber's activities was not allowed to survive. Though the lime tree was left standing, the inscription marking its origin was carefully chiselled away.

On Germany's defeat, Dahlem was incorporated in the American Sector of Berlin. Soon after the arrival there of the American occupational forces, news came through that the Haber Institute was still standing, but entirely empty. The Nazi occupants had been eliminated, but all equipment had vanished too. A little later it became known that the physicist Prof. Hartmut Kallmann, a former pupil and close collaborator of Haber for many years, had taken possession of the empty shell. Kallmann, who had himself narrowly escaped racial liquidation by the Nazis, had returned after eleven years of interruption of his scientific work, with the intention of re-starting once more, if possible, the great centre of physical chemistry in Dahlem.

Haber's memory was restored to honour. On February 2 of this year the 'Haber Linde' was solemnly re-dedicated and its inscription renewed. The chief speaker on the occasion was Prof. Kallmann; other addresses included those by the Ober-Burgermeister of Berlin, the Burgermeister of Dahlem and the director of the People's University of Berlin. Of Haber's closer colleagues there were present Prof. K. F. Bonhöffer and Prof. Otto Warburg.

In his speech Dr. Kallmann recalled that eleven years earlier Haber's memory had been honoured on the anniversary of his death by a gathering of his friends who had remained in Germany under the Nazis. Members of university staffs (who in Germany are State officials) were forbidden attendance by express order of the Government; yet the hall was packed—"all had come", said Kallmann. This certainly was a noteworthy manifestation of independence in German scientific circles.

Dr. Kallmann revealed that in 1935 he (with many others) had still thought of the Nazi regime as a passing phenomenon; the subsequent "unspeakable horrors beyond all human imagination" had not been expected. Outside observers may regard this error as throwing a serious responsibility on German academic circles. Of this Dr. Kallmann appears well aware. Urging the resumption of every effort to advance scientific knowledge and to cultivate the arts of peace, he adds that this "may perhaps be a modest contribution to the necessary reparation of the measureless disaster which has been brought upon the world from this country". "Perhaps," he continued, "this could also form a contribution to the reconciliation of peoples. Perhaps the people beyond the frontiers of this country would then cease to think only of its evils, but remember also that from this country work has been done which belongs to the noblest creations of the human mind."

In a letter recently received from Dr. Kallmann, I find the same burning enthusiasm for science which pervaded his speech. Work, work, honest work, he says, is the only possible way to the moral salvation of Germany; and then—to my surprise—I find him expressing the confident hope to be soon granted a "licence for research" (*Forschungserlaubnis*). So apparently he has not yet been allowed to start research investigations.

It would seem to me that the values of science and humanity, restored to Germany by Allied victory, are damaged if people like Dr. Kallmann are still left to-day waiting for permission to resume their work. There may be, among those German men of science who resisted Nazism at great risk to themselves, some who occasionally lacked political acumen; but we must respect their integrity and should not delay any longer upholding with them freely and openly the fellowship of science. M. POLANYI

EXHIBITION OF BRITISH SCIENTIFIC INSTRUMENTS AT STOCKHOLM

THE first exhibition of British manufactured goods to be held abroad since the War was held in Stockholm during May 24–June 4. It was promoted by the British Scientific Instrument Manufacturers' Association in co-operation with the Royal Swedish Academy of Engineering Sciences, the Swedish Association of Technical Physicists and the British Council. The exhibition was housed in the Technical Museum, Stockholm, by courtesy of the director, Mr. Althin.

Forty-one firms of scientific instrument manufacturers participated, and a comprehensive display of recently developed apparatus was shown that should considerably enhance the prestige of British-made goods in the Scandinavian countries. The fact that the invitation to arrange an exhibition emanated from Swedish sources is a measure of the interest of Swedish men of science and industrialists in British manufactured goods, and the demand that exists in that country for precision apparatus.

The Technical Museum is situated in beautiful surroundings, along the edge of Lake Djurgärdsbrunnsviken, about two miles from the centre of the city. The whole of the ground floor, consisting of three large halls, a lecture theatre, and reception hall, was made available. An entrance charge of 20 ore (about 3*d*.) was made, this being the normal charge for admission to the Museum.

The opening ceremony was performed by H.M. Minister, Mr. C. B. Jerram, before a gathering of some three hundred scientific workers and industrialists, headed by Prof. Nauckoff, president of the Swedish Royal Academy. In the course of his remarks the Minister referred to the progress made in scientific achievement during the past six years of war, and averred that some good could not fail to come out of the combating of evil. The perfection of many of the instruments shown was directly due to the struggle of humanity against the forces of evil. In the mass of destruction there have germinated such devices which would become invaluable aids to the happiness, prosperity and security of the human race.

An inaugural address was given by Sir Charles Darwin, director of the National Physical Laboratory, on "Scientific Instruments in Britain", in which he stressed the interdependence of scientific men and instrument manufacturers. The man of science is usually first in the development of new ideas and methods; but the instrument-makers put the ideas into concrete form, and thus provide the instruments and apparatus which enable the scientific workers to develop new ideas. He spoke of the work of both during the War, and gave a brief résumé of the development and work of the National Physical Laboratory in Great Britain with particular reference to the Division of Metrology, which played a great part in the standardization and accurate gauging of fabricated parts. In referring to the mobilization of scientific workers in Britain during the War, he remarked that many were required to do work outside their own specialized field; on the whole, they have probably gained by a widening of outlook that could scarcely have been obtained in any other way.

The exhibition was open to the public from 12 o'clock to 4 o'clock, and on four evenings from 7 o'clock until 9 o'clock. Admission was also permitted in the mornings, by tickets issued by the exhibitors, enabling demonstrations to be given to those specially interested.

A series of fifteen lectures by specialists were given during the exhibition, each occupying one hour. The lectures, which covered a wide range of subjects of a scientific nature, mostly directly associated with the instrument industry, were one of the outstanding successes of the meeting. Three sessions were devoted to British industrial films, presented by the British Council.

The average attendance during each session was about 800, and the fact that a Conference of some three thousand engineers from the Scandinavian countries was being held in Stockholm during the same period ensured that the technical level of the visitors was high. A visit was paid, during one of the public sessions, by the Crown Prince and Princess of Sweden.

The general organisation of the exhibition was in the hands of a Swedish committee, under the chairmanship of Prof. G. Borelius. The layout was such that no exhibit could be overlooked, the stands, which were all of the open type, being so arranged that they formed part of a circuit. The décor and arrangement were uniform throughout, and though subdued the effect was very tasteful. Stands were ready for exhibitors when the apparatus arrived, and, what is most rare, the whole exhibition was complete in time for a press visit on the afternoon prior to the opening. The press publicity was well handled, liberal space was devoted in both daily and weekly journals, and a fully illustrated catalogue was available. Swedish scientific journals have arranged for the publication of many of the lectures.

Prior to the opening, the director of the Museum and members of the organising committee made a critical survey of the whole exhibition, requiring the removal of redundant exhibits. In no case would they permit any exhibit or individual idea of display to disturb the general layout or appearance of the exhibition as a whole. The lighting was uniform and adequate, and ample space available in the centres of the halls to prevent congestion. It is the due of the Swedish committee that this comment be made, since by their labour and keen insight they succeeded in providing almost ideal conditions for a highly successful exhibition, which cannot fail to add considerable prestige to British scientific instruments among the Scandinavian countries, and will provide a marked stimulus to export trade in a field that, prior to the War, was largely in German hands.

It is understood that invitations have already been received by the Scientific Instrument Manufacturers' Association to arrange similar exhibitions in other European countries.

RHUBARB LEAVES AS A FEEDING-STUFF FOR RABBITS

By W. KING WILSON
Harper Adams Agricultural College

SINCE the introduction of rhubarb into Britain from the U.S.S.R. in the sixteenth century it has become widely cultivated as a culinary plant. The leaves, comprising 18–25 per cent of the crop, are wasted as they are considered to be unfit for animal food.

During periods of food shortage, for example, the First World War, rhubarb leaves have, however, been used for human consumption to supplement shortages of fresh green vegetables, with the result that many people became ill from oxalic acid poisoning and a number of them died[1-11]. The toxic effects were so widespread that rhubarb leaves have since been regarded as a dangerous foodstuff for man and beast.

The literature on rabbit-keeping has, since then, contained numerous warnings to livestock breeders against feeding rhubarb or rhubarb leaves. These warnings have been given by well-known writers, breeders, a veterinarian and the Domestic Poultry Keepers Council[12-19]; but a search of the literature has failed to provide evidence of its toxic effect on the rabbit[20,21]. Since the green tops of this plant have been fed intermittently, during temporary shortages of fresh fodder, it was considered desirable to investigate the effect of giving rhubarb as the sole source of green-food in the diet over a continuous period with the view of observing possible seasonal effects.

The chemical composition of the leaves has been given in various countries, and shows calorie values

compared with the edible stem (leaves 28–12 and stem 18 gm. per 100 gm.), while the fibre content does not show the same steep rise that is common in grass during summer-time; and it appears to be a useful source of proteins and minerals.

TABLE 1. CHEMICAL COMPOSITION OF RHUBARB LEAVES, PER CENT

Water	Protein	Fat	N. free extr.	Fibre	Ash	Ref.
90·0	2·8	0·4	3·9	1·0	1 9	(23)
91·5	1·6	0·1	5·1	0·7	1·1	(24)
64·5	0·3	0·1	2·6		0·5	(22)

Preliminary observations were made on four mature rabbits, two of each sex, which received a mixed diet including one rhubarb leaf each on the first day, rising to 4 oz. per head by the twenty-fourth day. After the first day there was no serious difficulty in getting them to eat rhubarb leaves. At the end of this time the rabbits were still in good condition and showed no abnormal symptoms.

Feeding Rhubarb Leaves v. Grass

A small feeding trial was started with twenty young Beveren rabbits, aged approximately ten weeks old. These were divided into two similar groups; the control group received grass as their green-food, and the other group received green rhubarb leaves (cut twice weekly), which they cleared satisfactorily by the fourth day. Both lots were also fed a basal allowance of growers meal mash, containing 1·8 per cent calcium, and water daily. Hay was given twice weekly.

Under this system both groups grew well on their respective foods during May and June. In May the young grass was of very good quality and the group fed on it showed only a very trifling advantage in live weight (up to 0·3 oz.); but from the second week of June (sixth week of test) there was a seasonal decline in the feeding value of this green-food, which is reflected in the small advantage in the live weights of the rhubarb group thereafter. After nine weeks comparison the rhubarb group had gained an average of 3·3 oz. more than the grass group. The average weekly weighings for the two groups are set out in Table 2.

TABLE 2. AVERAGE LIVE WEIGHTS (LB. AND OZ.)

	Control grass		Rhubarb leaves		Month
Initial weight	3	2·0	3	2·0	
Week 1	3	7·2	3	7·0	May
2	3	14·0	3	13·7	"
3	3	15·2	3	14·9	"
4	4	4·0	4	3·9	"
5	4	6·5	4	5·7	June
6	4	6·9	4	9·6	"
7	4	14·1	4	15·8	"
8	4	14·7	5	1·1	"
9	5	1·7	5	5·0	June/July

There was no mortality or sickness in either group, and at the tenth week of the feeding comparison half of each group was slaughtered. These were all in excellent condition with substantial deposition of internal fat, irrespective of the feeding group. Carcasses were of ideal size for the domestic trade. The killing weights are summarized in Table 3.

TABLE 3. AVERAGE SLAUGHTER WEIGHTS

Group	Live weight		Carcass cold		Skin	Carcass percentage
	lb.	oz.	lb.	oz.	oz.	
Grass	5	4·4	3	3·4	8·9	60·9
Rhubarb	5	3·4	3	2·6	9·2	60·7

The carcasses, from both groups, dressed out at a satisfactory ratio to live weight for their age, but failed to show any important difference due to diet.

The remainder of the stock continued to receive grass, including weeds during a droughty spell, or alternatively rhubarb, as their only source of green-food throughout July to the end of October, and the live weights in each of these months showed the rhubarb leaves maintaining a slight advantage over grass, with one exception in September, when they were equal. This was after feeding more weeds than grass to the control group. At the end of October (six calendar months on the respective green-foods) the rhubarb group were heavier by an average of 4 oz. (weights, grass 7 lb. 3·2 oz. and rhubarb 7 lb. 7·2 oz.). Their condition was then noted as 'very good to excellent' and there was no discernible difference in the fur development between the two groups. By this time, the supply of green rhubarb leaves was nearly exhausted and the tops were dying. The feeding comparison then terminated, after demonstrating that this waste material is a satisfactory alternative for grass in these rabbit rations.

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NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT

THE twenty-eighth annual report of the National Research Council of Canada, for the year 1944–45 (Ottawa. Pp. 40), includes the report of the President, the financial statement and the reports of the directors of the Divisions of Applied Biology, Chemistry, Mechanical Engineering, Physics and Electrical Engineering, and of the Research Plans and Publications Section and the Section on Codes and Specifications, together with a table of scholarships awarded.

Except for the long-term project on forest-tree breeding, all the work of the Division of Applied Biology was related to the war effort. The fermentation of wheat to give butylene glycol received detailed study in the pilot plant, and the time of fermentation was reduced almost by half by removing carbon dioxide under reduced pressure. Cyclic acetal has been added to the list of chemicals obtainable from butylene glycol, and a continuous process worked out for methyl ethyl ketone. A greatly

improved method has been developed for the polarimetric determination of starches, and tetrahydrofurfuryl alcohol, easily made from agricultural waste, is a promising permanent type of anti-freeze. A pilot plant was constructed for separating starch and gluten from wheat, based on processes developed in the laboratory, and the expansion of the work on industrial utilization of agricultural wastes and surpluses included the building of a new laboratory. Methods for the extraction of rubber from native and introduced plants continued to receive attention, and the rubber pilot plant was adapted to include solvent-extraction methods. Work on 'tropicalization' assumed major proportions during the year and much Service equipment was placed under test. Copper dimethylglyoximate and other chemical treatments gave promising results for rot-proofing fabrics, especially canvas. In the food field, the work on dried eggs was expanded to include dried egg and sugar mixtures, a product which has shown distinct promise. Work on liquid and shell eggs was renewed, with the emphasis on methods extending their storage life. Co-operative studies with the Ontario Research Foundation and the Associate Committee on Grain Research were continued on processing and treating domestic oils for food. An investigation was initiated on the treatment of butter to improve its stability for use by the Services under tropical conditions.

The various sections of the Division of Chemistry also continued to operate almost exclusively on war problems. Continued co-operation with the Directorate of Chemical Warfare and Smoke included studies to improve the pilot plant yields of organic chemicals and syntheses of new toxic materials, while a small group was engaged on fundamental studies of long-range interest to synthetic rubber manufacture. The design of a pilot plant for ethylene oxide was completed and erection begun. Particular attention was paid to catalysts used in the conversion of ethylene to ethylene oxide. In the Plastics and Colloid Section the chief projects related to the study of density-temperature relations of some plastic materials and the physical properties of plastic and plasticizer combinations. The Plastics Testing Laboratory carried out investigations on waterproof maps, testing of safety goggles, the treatment of leather components for use in the tropics, the improvement of sole leather by impregnation with resins and the examination of periscope prisms to determine the reason for bubble formation in the plastic laminating layer. The Textile Section continued its investigations with special attention to rot-proofing technique. Work on protective clothing for the Air Force was a major project; attention was also given to wear resistance and shrinkage of Service socks. At the request of the Army medical authorities, the oiling of blankets was investigated as a method of preventing transfer of infection in hospitals. The Rubber Laboratory again gave special attention to synthetic rubber compounding, and the scarcity of carbon black required work to determine the effect of reducing the proportion in such materials as footwear. Work was also done on non-skid deck covering. In addition to the problems on the tropicalization of vehicles, packaging of metallic parts, etc., the Corrosion Laboratory carried out long-term investigations of sea-water corrosion of alloys and protective coatings, the study of corrosion inhibitors in tap water and in anti-freezes, the testing of rust-preventing oils and preliminary work on the possible cathodic protection of ships.

The Division of Mechanical Engineering devoted almost its full effort to war work for the Armed Services and the Department of Munitions and Supply. The Hydraulic Laboratory and an addition to the Gasolene and Oil Laboratory were completed and occupied. Fundamental research on the aerodynamic balancing of aircraft controls was extended. Special attention was given to the design and construction of artificial limbs in moulded plywood and moulded synthetic resin materials, and many tests were performed on synthetic resin adhesives with particular reference to the technique of metal bonding.

In the Division of Physics and Electrical Engineering the work was largely in the field of marine physics. In the Acoustics Laboratory three major anti-submarine projects were completed. The main effort of the Optics Laboratory was devoted to research in aerial photography; this work was sponsored by the Canadian Photographic Research Committee. Some thirty-five reports were issued but the circulation list was restricted by security regulations. It can be expected that a new basis for the design of photographic objectives will be developed and photographic lenses will have a greatly improved performance. Much work has been done on night photography for reconnaissance purposes.

In addition to reports on literature searches, the Research Plans and Publications Section made nearly three times as many translations as in the preceding year. During the year, eighty-eight papers were added to the Council's list of publications, which has now attained such proportions that it has been decided to re-issue the list to include author and subject indexes as well as the numerical chronological list of titles. Among the reports issued during the year may be mentioned abstracts on fungi and bacteria affecting various materials, storage of coal and a revised and enlarged edition of abstracts on penicillin and other antibiotic substances, as well as abstracts on the utilization of sawdust.

CONTEMPORARY CULTURE OF THE CAHITA INDIANS

THE Cáhita Indians of western Mexico consist of two surviving groups, the Yaqui and the Mayo. As a result of his visits to them, Ralph L. Beals has already published an account of what can be gleaned about their aboriginal culture (*Ibero-Americana*, No. 19. Calif. Univ. Press, 1943). He now shows (*Bull.* 142, *Bur. Amer. Ethn.*, Smithsonian Instit., 1945) that their modern culture is a vigorous hybrid, which differs from those of the Indians of the United States in that it is holding its own with that of the whites, though it continually absorbs elements from it. It is by no means sure, as the author points out, that the Indian elements in Mexican culture will be altogether lost in the final synthesis.

This useful account sets out to deal particularly with the ethnography rather than the social anthropology of the Cáhita; nevertheless it contains much information about the latter aspect. There is an interesting summary of the material culture, but much of the book is taken up with accounts of the religious observances. Superficially these appear to centre largely around the Christian Church and calendar, but they contain so many aboriginal elements and introduce the Catholic priest so seldom,

that they constitute a hybrid which is almost wholly aboriginal in spirit. More specifically aboriginal are certain features which they call the "Religion of the Woods".

Not the least interesting part of the work is the account of how the Yaqui and the Mayo, though their cultures are almost identical in content, react very differently to contact with the Mexicans. The Mayo seems to preserve his way of life by passive resistance, and his attitude is graphically described by the Spanish expression 'muy cerrado' (very shut), in which he resembles many Andean tribes. The Yaqui, on the other hand, is, and has been throughout his history, a fighter, and he preserves his culture by his aggressiveness. The explanation of this deep psychological difference between two closely related groups is one of the principal problems in connexion with these Indians which still await solution.

G. H. S. BUSHNELL

WOOL TEXTILE RESEARCH IN AUSTRALIA

THE Australian Council for Scientific and Industrial Research is to embark on an extensive programme of research on wool production and manufacture. Australia has a sheep population of approximately 120,000,000, from which is derived the most valuable item of her export trade. To aid this valuable industry the Federal Parliament has recently enacted the Wool Use Promotion Act (1945) and the Wool Tax Act (1936/45) (see *Nature*, 157, 71; 1946). The latter of these legislative measures provides for the collection of 2*s*. per bale on all wool produced. This will bring in an annual income of about £300,000, and this sum is to form the Wool Use Promotion Fund, which is to be administered by the Wool Board, newly constituted under the Wool Use Promotion Act, "to make arrangements with persons, authorities and organizations in Australia and in other countries for joint measures of publicity or other means for the promotion of the use of wool".

The Wool Use Promotion Act empowers the Federal Treasury to create from the consolidated revenue the Wool Research Trust Account of an amount equal to the Wool Use Promotion Fund. These moneys are to be used mainly by the Council for Scientific and Industrial Research. The Council is thus assured of an annual income accumulating from year to year of approximately £300,000 with which to plan its research programme.

Approximately half of this money will be devoted to a considerable expansion of the work of the existing laboratories of the Council which have, for some years, been studying the health and nutrition of the sheep and for the initiation of new work on genetics and physiology. Equal importance, however, will be given to research on wool as a textile, for although only 12½ per cent of Australian wool is processed in the Commonwealth, it is considered to be in the interests of Australia to have the results of textile research applied outside as well as within the Commonwealth.

Textile research is a field into which the Council for Scientific and Industrial Research has not previously entered; in fact, little research of this type has been undertaken in Australia either in the universities or elsewhere. The Federal Government has, for some years, made an annual contribution to the Wool Industries Research Association in the United Kingdom, and this support will continue to be given. Recently, four men eminent in the field of textile research were invited to Australia to advise the Council for Scientific and Industrial Research on the initial planning of its researches in this field. These were Prof. J. B. Speakman, professor of textile technology of the University of Leeds; Mr. B. H. Wilsdon, director of the Wool Industries Research Association, Leeds; Dr. A. C. Goodings, director of textile research, Ontario Research Foundation, Canada; Dr. F. T. Peirce, formerly of the Shirley Institute, British Cotton Industries Research Association, now director of research, North Carolina State College of Agriculture and Engineering, University of North Carolina, Raleigh, N.C.

It has now been decided to form a Division of Wool Textile Research within the Council for Scientific and Industrial Research. This division will have several sectional laboratories devoted to the various aspects of the problem. Although it is the intention to appoint senior scientific men with the required qualifications to take charge of the various sections of the work, the whole endeavour will be co-ordinated under a chief of the Division, in line with the normal administrative arrangements of the Council. The chief will be responsible to the Executive Committee of the Council for the planning of all aspects of the research programme, and the ultimate success of the work will very largely depend on his initiative and ability.

Each of the advisers has emphasized the need for basic research, both in the field of protein science and in applied science, in which the more fundamental knowledge can be interpreted in terms of the manufacturing processes of the industry. If this work is to prosper, the early years must of necessity be devoted to the building up of a competent scientific team in which particular attention must be paid to the more fundamental sciences which are the basis of the textile industry.

FISH MORTALITY DUE TO A BROWN FLAGELLATE

AN extensive mortality of fishes in two brackish-water lakes, Ketting Nor and Selsø Sø in the Lesser Belt region of Denmark, has been found by C. V. Otterstrøm and E. Steemann Nielsen (*Rep. Danish Biol. Sta.*, 44; 1939) to be associated with a transitory dominance in the plankton of the brown flagellate *Prymnesium parvum* Carter, 1938. This cryptomonad has been found before in Europe, always in brackish waters, and in Holland it was also implicated in large-scale destruction of fishes.

Ketting Nor was studied in 1938, immediately after the catastrophe, and again a year later when conditions were returning to normal. A similar crisis was investigated in Selsø Sø in 1939. It was thought that one of the contributory causes was the increased salinity due to the fjord water entering around the lock-gates, which were imperfectly fitting in both lakes. In Ketting Nor it is probable that this accounted for a reduction in the rate of growth of the plants (the reed crop dropping to half normal in 1938), particularly of the submerged Characeæ, which harbour a rich fauna.

This disturbance of balance between the bottom vegetation and the plankton favoured the latter, resulting in an almost pure growth of the flagellate, to a concentration of 1,200,000/cm.^{3}—giving a transparency of only 40 cm. Owing to the exclusion of light, the growth of the Characeæ was finally inhibited, the dead mass yielding up its nitrates and phosphates; these, added to those bound by the plankton, probably accounted for the increase of 9·3 mgm. nitrate and 0·27 mgm. phosphate per litre in the autumn of 1938. Though all the fish died, the following arthropods were apparently unaffected: Chironomids, *Mysis*, *Sphæroma* and *Carcinus*. The small fish which appeared in the following year may have represented a refugee population from the freshwater affluents. In Selsø Sø, *Prymnesium parvum* again dominated the plankton, but only reaching half its concentration in Ketting Nor, though other phytoplankton contributed to produce the same transparency.

Experiments on the effects of the flagellate water from Ketting Nor on fishes showed that *Prymnesium* by itself is harmless, but a colloidal metabolite, which is retained together with the flagellate only by an asbestos filter, and separated from it by shaking a culture with charcoal, has definite toxic effects on fishes. Although the flagellate is killed at 41° C., the poisonous effect remains after heating to 60° and 80°, though it disappears on boiling. The poisoning results, not in hæmolysis in the gills, as previously supposed, but in a generalized nervous paralysis. The effect is permanent and cannot be cured by transferring the fish to clean water. The poison is apparently cumulative in the medium, for it has only weak effects in young cultures; but in older cultures it is present in greater concentrations, which become maximal in the autumn.

NORA G. SPROSTON

EXPERIMENTAL FORESTRY IN SWEDEN

IN No. 32 of the Reports of the Swedish Institute of Experimental Forestry (1940–41) (Centraltryckeriet, Esselte A.-B., Stockholm, 1941), Erik Björkman in a paper entitled "Mycorrhiza in Pine and Spruce Seedlings grown under Varied Radiation Intensities in Rich Soils with or without Nitrate Added" gives the results of a study of the root and mycorrhiza development of young pine (*Pinus sylvestris*) and spruce (*Picea excelsa*) grown in eight different soils—most of them soils rich in nutrients—under different light conditions, with or without available nitrogen added up to very high doses. These two species are commercially the most important of the timbers in the Swedish forests. The study forms part of an investigation planned by Prof. H. Hesselman, who had already briefly reported in 1939 on its general layout and main results. Some of the data reported used by the author are borrowed from a forthcoming publication by Prof. Hesselman.

The soils used are listed as follows: mull, oakwood (oakburst with sparse ground-cover of herbs and dense undergrowth of hawthorn, bird-cherry, etc.); mull, spruce-wood (cultivated pine forest with abundant *Oxalis*); mull, alderwood (alder grove (fen wood) with *Urtica dioica*); mull, beech-wood (beech wood with *Asperula, Cardamine impatiens*, etc.); garden soil; mull rich in calcium, spruce wood (spruce wood with abundant *Mercurialis*); mor plus sand (mixed coniferous wood with *Myrtillus*, etc.); mull spruce wood (closed spruce wood with mosses). The paper discusses the investigations and experiments undertaken.

In a paper by Lars-Gunnar Romell on "Studies on Pruning in Pine and Spruce", an analysis is made of some 3,000 knots in unpruned or pruned Scots pine and some 1,200 in pruned Norway spruce. In addition, data were collected on growing trees and stands. There appear to be considerable variations in the time at which knots heal over, and to some extent in the way in which the healing takes place. The analyses made display this in an interesting fashion. It is mentioned that, in one case of green-pruning of branches of spruce, an insect attack developed after the green-pruning in late spring (the best time to green-prune is late winter or early spring), all the pruned trees being attacked three weeks after the pruning by the six-toothed bark borer (*Tomicos sexdentatus*), a not surprising result. This is a most interesting and an important subject in its connexion with the spacing of plants in plantations, and the corresponding costs.

An interesting contribution to the discussion "On the Importance of the Ripening of the Humus in Clear-cut Areas Prior to Reafforestation" by L. Tirén describes experiments carried out in certain marked strips of cut-over forest to ascertain the results of allowing the areas to lie fallow for a varying period of years. There were two sections in one forest of which the several strips lay unplanted for six, four and two years, and the other for eight, six, four and 0 years. The object was to ascertain the ripening effects on the humus layer of the varying periods of exposure. So far, the opinion appears to be that the experiments have not lent support to the view that a certain ripening period prior to afforestation would decidedly and permanently improve the results of the afforestation. The investigations were carried out in Norrland.

FORTHCOMING EVENTS

Tuesday, July 16

BRITISH STANDARDS INSTITUTION (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Annual General Meeting.

Friday, July 19

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University New Buildings, Teviot Place, Edinburgh), at 10.30 a.m.—Scientific Papers and Demonstrations.

Saturday, July 20

BRITISH ASSOCIATION (in the Hall of the British Medical Association, Tavistock Square, London, W.C.1), at 3.30 p.m.—Annual General Meeting, followed by Sir Richard Gregory, Bt., F.R.S.: "Civilization and the Pursuit of Knowledge" (Presidential Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DISTILLERY EXPERT, Government of the United Provinces, India—The Office of the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (July 20).

JUNIOR LECTURER OR LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 20).

LECTURER AND AN ASSISTANT IN THE DEPARTMENT OF MATHEMATICS—The Secretary, The University, Aberdeen (July 20).

ASSISTANT LECTURER IN BOTANY AND ZOOLOGY, and a responsible LECTURER (Senior Assistant) IN PHYSIOLOGY—The Principal, Chelsea Polytechnic, Manresa Road, Chelsea, London, S.W.3 (July 20).

DEPUTY DIRECTORS IN THE BURMA VETERINARY DEPARTMENT—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (July 20).

LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, King's College, Strand, London, W.C.2 (July 20).

LECTURER IN GEOLOGY (Grade II)—The Registrar, University College, Southampton (July 20)

HEAD OF THE ENGINEERING DEPARTMENT (Grade II), HEAD OF THE SCIENCE DEPARTMENT (Grade II), and a SENIOR ASSISTANT LECTURER IN PHYSICS—The Acting Clerk to the Governors, Nottingham and District Technical College, Shakespeare Street, Nottingham (July 22).

READER IN CIVIL ENGINEERING—The Registrar, The University, Manchester 13 (July 22).

LECTURERS IN THE DEPARTMENT OF MECHANICAL ENGINEERING of the Natal University College, Durban—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (July 22).

LECTURER IN ZOOLOGY—The Secretary, The University, Aberdeen (July 25).

ASSISTANT IN THE CHEMISTRY DEPARTMENT—The Secretary, The University, Aberdeen (July 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOLOGY, and ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, The University, Sheffield (July 31).

DAIRY OFFICER in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Department of Agriculture and Lands, P.O. Box 387, Salisbury, Southern Rhodesia (July 31).

LECTURER, and a UNIVERSITY ASSISTANT, IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, St. Andrews (July 31).

LABORATORY ASSISTANT (male, Grade A) at the Marine Biological Station, Millport—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (July 31).

LABORATORY ASSISTANTS (male or female) IN CHEMISTRY, ENTOMOLOGY, PLANT PATHOLOGY and BACTERIOLOGY at various centres in England and Wales of the National Agricultural Advisory Service—The Secretary, Ministry of Agriculture and Fisheries, 4 Bickenhall Mansions, London, W.1, endorsed 'N.A.A.S.' (July 31).

LECTURER IN ANALYTICAL CHEMISTRY—The Secretary, The University, Aberdeen (July 31).

LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Leeds 2 (July 31).

LECTURERS (2) IN THE DEPARTMENT OF GEOLOGY—The Secretary, The University, Aberdeen (July 31).

ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Sheffield (July 31).

PROBATIONARY ASSISTANT LECTURERS IN THE DEPARTMENTS OF MATHEMATICS, PHYSICS, CHEMISTRY, BOTANY and ZOOLOGY—The Secretary and Registrar, University College of North Wales, Bangor (July 31).

AGRICULTURAL ENGINEER for service with the Government of the United Provinces—The Office of the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (August 3).

CHIEF BIOCHEMIST for the Animal Research Station, Department of Agriculture—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (August 3).

ASSISTANT LECTURER IN PHARMACOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (August 5).

ASSISTANT LECTURERS (2) IN GEOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (August 15).

INSPECTOR under the Alkali etc. Works Regulation Act, 1906—The Director of Establishments, Ministry of Health, Whitehall, London, S.W.1 (August 15).

PROFESSOR OF GEOLOGY, and a LECTURER IN MATHEMATICS, in the University of Tasmania—The Agent General for Tasmania, Australia House, Aldwych, London, W.C.2 (in Hobart, August 15).

PROFESSOR OF SOCIAL ANTHROPOLOGY in the Rhodes University College, Grahamstown—The Ministry of Labour and National Service, London Appointments Office, 1-6 Tavistock Square, London, W.C.1, quoting Ref. No. F.A.550 (August 26).

ASSISTANT LECTURER IN PHYSICS at the Bradford Technical College—The Director of Education, Town Hall, Bradford.

PROFESSOR OF GENERAL CHEMISTRY—The Secretary of the University Council, Trinity College, Dublin.

SENIOR LABORATORY STEWARD—The Head of the Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3.

LABORATORY STEWARD IN THE DEPARTMENT OF PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool 3.

LECTURER IN PHYSIOLOGY—The Registrar, University College, Nottingham.

LECTURER IN ELECTRICAL ENGINEERING at the Municipal Technical College and School of Art—The Director of Education, Blackburn.

ASSISTANT LECTURER (woman) IN CHEMISTRY and TUTOR FOR WOMEN at the Technical College—The Director of Education, Bradford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 62, Part 2, No. 21: Degenerative and Regenerative Changes at the Site of Trauma after Experimental Crush Injury of Peripheral Nerves. By Dr. P. Bacsich and G. M. Wyburn. Pp. 182–188 + 5 plates. 4s. Vol. 62, Part 2, No. 22: Placental Fusion in Mice. By J. G. Carr. Pp. 189–190 + 1 plate. 9d. Vol. 62, Part 2, No. 23: Infertility and Embryonic Mortality in the Domestic Fowl. By Dr. J. S. S. Blyth. Pp. 191–201. 2s. (Edinburgh: Oliver and Boyd, 1945.) [31

Colonial Office. Inter-Territorial Organisation in East Africa. (Colonial No. 191.) Pp. 12. (London: H.M. Stationery Office, 1945.) 2d. net. [71

Lecture on Industrial Non-Ferrous Alloys. By Dr. Harold Moore. Pp. 44. (London: Royal Institute of Chemistry, 1945.) [81

Money and Banking. Pp. 36. (London: Joint Council of Monetary and Economic Research, 1945.) 1s. 6d. [81

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain, Vol. 34: Rock Wool. By E. M. Guppy and Dr. James Phemister. Pp. ii + 46. (London: H.M. Stationery Office, 1945.) 9d. net. [81

University of Leeds. Third Montague Burton Lecture on International Relations: Victory and After. By Prof. Gilbert Murray. Pp. 16. (Leeds: The University, 1945.) 6d. [81

Thorley's Farmer's Diary and Almanack, 1946. Pp. 48. (London: J. Thorley, Ltd., 1946.) 6d. [81

The Impact of War on Civilian Consumption in the United Kingdom, the United States and Canada. A Report to the Combined Production and Resources Board from a special combined Committee on Non-Food Consumption Levels. Pp. 163. (London: H.M. Stationery Office, 1945.) 2s. 6d. net. [81

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Ministry of Public Works, Egypt. Physical Department Paper No. 48: The Nile Basin. Third Supplement to Vol. 4: Ten-day Mean and Monthly Mean Discharges of the Nile and its Tributaries for the Years 1938–1942 and Normals for the Period 1912–1942. By Dr. H. E. Hurst and R. P. Black. Pp. v + 297. (Cairo: Government Press, 1945.) P.T. 50; 10s. [1312

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Your Opportunity in Alberta. Compiled by L. P. Danis. Pp. 64. (Edmonton: Government Printer, 1945.) [1712

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Indian Forest Leaflets. No. 78: Bending of Skis. By M. A. Rehman and S. M. Ishaq. Pp. ii + 6 + 4 plates. 6 annas. No. 79: Laminated Skis. By D. Narayanamurti and V. Ranganathan. Pp. ii + 3 + 5 plates. 6 annas. No. 86: The Efficiency of Enumerations, 5. Upper Assam Tropical Evergreen Forest; 6. Typical Calculations. By Dr. A. L. Griffith. Pp. iv + 12. 6 annas. (Dehra Dun: Forest Research Institute, 1945.) [1812

Indian Forest Bulletin, No. 124: Indian Woods for Battery Separators. By M. A. Rehman and S. M. Ishaq. Pp. 20 + 2 plates. (Dehra Dun: Forest Research Institute, 1945.) 12 annas. [1812

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Mitteilungen der Naturforschenden Gesellschaft Bern. Neue folge, Band 1. Pp. xliv + 176. Neue folge, Band 2. Pp. xlv + 130. (Bern: Paul Haupt, 1944–1945.) [1812

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TRAINING FOR THE COLONIAL SERVICES

THE Colonial Service is called upon to-day to deal with a whole range of problems that had not been contemplated when a course of training for entrants was first devised in 1924. The administrative officer, once concerned mainly with the maintenance of law and order, is now expected to be the active promoter of all those types of activity that have come to be grouped under the heading 'Development and Welfare'. A new type of training is called for, more appropriate to these new functions.

British faith in the amateur dies hard; in the Indian, Home and Sudan Civil Services, a university degree, in no matter what subject, is regarded as both a necessary and a sufficient qualification. In the case of the Colonial Administrative Service, this has been supplemented since 1924 by a course at Oxford or Cambridge, lasting one university session, in subjects relevant to the work for which the students are preparing—law, surveying and field engineering, colonial history, colonial administration, geography, anthropology, tropical agriculture and forestry, tropical hygiene, and languages. Contrast the provision made by the other major colonial Powers—the École Nationale de la France d'Outre-Mer in Paris, the Université Coloniale at Antwerp, the five-year colonial courses given at the Universities of Leyden and Utrecht. A recent addition to this list is the Australian School of Pacific Administration, which was opened in May of this year and is to be incorporated in the Australian National University. Australia's present plans are for a training period shorter than a normal university course—three months before, and two years after, the first tour of service. In all the other cases, the syllabus for a university degree is built around the special interests of the man preparing for work in the colonial field.

Britain still sees virtues in a 'general'—some might almost say an irrelevant—education. So the administrators of the British Colonial Empire must still cover the enlarged field of studies now considered necessary within the limits of the time they can spare when they have completed an undergraduate course. This has now been somewhat extended; there is to be a preliminary course of four terms (with special study during the 'long vacation'), and an additional one of six months after the first tour of service. The proposals which have just appeared* are based on a memorandum by Sir Ralph Furse, director of recruitment to the Colonial Office, which was discussed by a committee representing the Universities of Oxford, Cambridge and London, with the Duke of Devonshire as chairman. The memorandum is published as an annex to the Committee's report. It is emphasized that the proposals are tentative and may be revised in the light of experience.

Under the new plan, entrants on selection will go first to Oxford or Cambridge, where they will spend two full terms and a shortened summer term (to the

* Colonial Office. Post-War Training for the Colonial Service Report of a Committee appointed by the Secretary of State for the Colonies. (Colonial No. 198.) Pp. 46. (London: H.M. Stationery Office, 1946.) 9*d*. net.

end of May) studying British Empire and Colonial history and administration, law, agriculture, geography and anthropology. They will then be allotted to their respective Colonies. The month of June and the following October term will be spent in London, mainly in the study of languages; to this the report would allot a minimum of three hours daily. At the same time, however, they are to take courses in the geography, sociology and administration of one of three major regions, West Africa, East Africa, or Malaya and the Pacific. The report remarks that "recruits are willing to work very hard so long as they believe that they are being given the tools for their future job". Willing they may be, but the breathless succession of lectures which this programme must involve is just what most university teachers would deplore. One wonders what was the compelling argument against devising a course extending over two university sessions.

During the 'long vacation', the students are to be given practical experience of the working of local government administration and of the social services in both urban and rural areas; this will presumably involve dividing them into small groups to be attached to different local authorities. This is the most interesting innovation in the proposed new course, and the one that most clearly reflects the new conception of the functions of the administrative officer; he is to be largely engaged in co-ordinating the work of specialists in 'development and welfare' schemes, and in encouraging the colonial form of local government—a native authority or whatever it may be—to take responsibility for the social services, which it is the present policy of Britain to extend as rapidly as possible. Another new proposal is that the second course, to be taken after the first tour of duty, shall be attended by officers of all the technical services as well as by administrative officers. This, it is hoped, will help to break down the isolation of the political from the specialist officer, and of specialist officers from one another, which has characterized too many Colonies in the past. It has been realized in Government quarters, ever since the Nutrition Committee reported in 1939, that the first essential in approaching any of the major problems of Colonial backwardness—malnutrition, soil erosion, illiteracy, disease—is the concerted attack, and most Colonies have recognized this to the extent of bringing the heads of all departments together to draw up development plans. At lower levels, however, co-operation is not yet taken for granted, and a combined course of training will have a most valuable influence in this direction. Sir Ralph Furse points out that the lectures recently introduced on the work and problems of the agricultural and forest services have already had good results.

The probationers are also to fit into their 'long vacation' a course of lectures on tropical hygiene and sanitation, and "possibly some instruction in" a number of miscellaneous subjects, the value of which seems open to question, judging from their titles. "Field Engineering", a reject from the pre-war course, evidently found an advocate who could not bear to see it go. "Colonial Accounts" appears from the text of the report to mean office routine work. "Tropical Housekeeping and Cookery" was introduced, it seems, in response to "colonial opinion"; but is an organised course required in order to explain that food goes bad quickly in hot climates?

Certainly no one could accuse the Committee of overlooking any subject likely to be of value to the administrative cadet; the question is rather whether so many can be adequately treated in the time available.

Sir Ralph Furse makes some interesting suggestions about the cadet's first tour of service. The work allotted to him should be planned with the view of giving him useful experience on different types of station and in different aspects of administration. He might be attached for short periods to officers of some of the technical departments. He should spend part of the tour at Makerere or Achimota in order to make the acquaintance of the educated African; and at the same time, since both those institutions are near Government headquarters, could see something of the working of a colonial secretariat and departmental headquarters offices.

Confirmation of appointment is to come at the end of this first tour. The officer will then return to Britain for a second course of six months, to be taken in London, and to consist mainly in discussions rather than in formal teaching. The subjects listed for this course are British colonial aims, comparative colonial administration, social administration, and one of several aspects of economics relevant to colonial problems. It is significant that in the case of the first subject alone, no indication is given of what the title covers; it could be argued that, though the methods of Colonial Powers differ widely, their aims are fundamentally the same, and that the first subject can only be treated as part of the second. In addition, students at this course will make a special study of some problem of anthropology, history, law, economics, education, agriculture or language. It is hoped that they will keep up a permanent interest in the subject selected. Provision is to be made, on a much larger scale than heretofore, for sabbatical leave for officers anxious to pursue their study further.

The second course is to be preceded by attendance at a summer school of the type that was so successfully organised at Oxford before the War. This will be open also to officers on leave in Britain. In future, summer schools are to be held both in Oxford and Cambridge, with the co-operation of London in providing lecturers and discussion leaders.

Sir Ralph Furse suggests that selected officers from the services of the Dominion mandated territories should be invited to attend all these courses; the report mentions them only in connexion with the summer school. While New Guinea was under military administration, the Australian Defence Department attached some importance to arrangements for giving selected officers experience of other Colonies, and a plan was adopted whereby four each year would be seconded for six months, of which three would be spent in a British Crown Colony and three at the Colonial Office. Only two had left Australia

when civil government was restored, and the Minister for External Territories did not continue the scheme. It has since been suggested that officers from the British Crown Colonies might attend the Australian School of Pacific Administration.

The financial provision involved in the necessary expansion of the Colonial Service and the new plans for training are discussed in a further memorandum*. This emphasizes, first, the need to implement the declared policy of throwing open the administrative service to suitably qualified men from among the colonial peoples by greatly increasing the opportunities for them to become qualified. For this purpose, a sum of £1,000,000 has been allocated from the Colonial Development and Welfare Fund over the next ten years for scholarships to enable selected colonial candidates for the service to receive education up to the same standards as those from Great Britain or the Dominions. The scholarships will be open to officers in subordinate grades of the public services as well as to entrants from outside.

The Government is also to provide a very much larger proportion than in the past of the cost of training, both general and technical. Formerly this was borne mainly by the Colonial Governments, though Great Britain financed scholarship schemes in the case of agricultural, veterinary and forest officers. For the next ten years, £1,500,000 is to be allocated from the Colonial Development and Welfare Fund for this purpose.

Principles are laid down governing the vexed question of salary scales for officers recruited locally and overseas. These are to be determined according to the nature of the work and the relative responsibilities, and are to be fixed at rates applicable to locally recruited staff, regard being paid to ruling levels of income in those classes from which the public services are recruited. Expatriation pay is to be provided for overseas officers, at rates which will take into account, among other things, the remuneration offered in alternative careers at home. The justification in these terms of the discrepancy in the salaries of officers recruited locally and overseas is logically unassailable; the recognition that the Colonial Service has to compete with alternative careers, and must offer conditions which will attract good men, is more important now than ever before; yet it is doubtful whether feeling on this point in the Colonies will be appeased by the division of the overseas officer's emoluments into salary and expatriation allowance.

Assistance is to be available under the Colonial Development and Welfare Act in special cases where a Colony's resources are insufficient to meet the cost of appointing overseas officers whom it needs.

The question whether Great Britain should take over the whole cost of the Colonial Service is discussed in a final paragraph. To do so would dispose of the argument that the Colonies should not be 'burdened' with the cost of a staff adequate in numbers and quality. This possibility is dismissed, however, on the ground that it would be politically retrograde to staff the higher grades of the Service with officers whose conditions of employment would not be controlled by the Colonial legislatures. The arrangement outlined in the paper is preferred because it "provides for a generous measure of assistance, so planned as to ensure that the Colonies will get a fully equipped Service in which the Colonial peoples themselves will take a progressively increasing share, while retaining the framework of existing institutions and safeguarding the principle of local self-government".

Although these reports contain many points which may be criticized, they are evidence of official recognition of the fact that the Colonial Services have many new problems to meet, for which the old training methods will be inadequate. The proposals are stated to be provisional, and their effects will be carefully examined.

* Colonial Office. Organisation of the Colonial Service. (Colonial No. 197.) Pp. 12. (London: H.M. Stationery Office, 1946.) 2*d*. net.

TRIASSIC FISHES FROM EAST GREENLAND

Studies on Triassic Fishes, I. (Palæozoologica Groenlandica)

By Eigil Nielsen. Pp. 394 + 30 plates. Meddelelser om Grønland, 138.) (København: C. A. Reitzels Forlag, 1942.) 22 kr.

WITH the exception of introductory pages and summaries, this work is identical with *Palæozoologica Groenlandica*, Bd. 1; parallel publication of fossil material will continue in this new journal and in *Medd. om Grønland*.

This volume, excellently printed in English on good paper during the German occupation of Denmark, is a most worthy member of the great series of monographs on fossil vertebrates produced under the direct influence of Prof. E. A. Stensiö of Stockholm. It shows the latest developments of techniques of freeing fossils from matrix, of serial sectioning, and of illustration, which have been worked out in Stensiö's laboratories. As in other large works of this school, the generous scale of publication allows extensive review of a whole group of fishes, and discussion of many problems; the excellent co-operation between the specialist palæontologists and the official expeditions is as marked as ever. Dr. Nielsen has himself spent several seasons, and wintered, in East Greenland, and collected much of the material now described. Vertebrate palæontology owes much to Dr. Lauge Koch's repeated, and outstandingly productive, expeditions to East Greenland.

Two genera of Eotriassic Actinopterygii are dealt with—*Glaucolepis* Stensiö (= *Pteroniscculus* White) with five species, and *Boreosomus* Stensiö (= *Diaphorognathus* Brough) with one; their stratigraphical position is well defined. Both genera were first described from Spitsbergen, and have been definitely recognized elsewhere only from Eotriassic rocks in East Greenland and Madagascar—an intriguing problem of distribution.

About two hundred specimens of *Glaucolepis*, in calcareous concretions, permit the most comprehensive and detailed description of a 'palæoniscoid' fish ever published. The head has been investigated by exquisite positive preparation (the specimen illustrated on pls. 13–17, showing the whole branchial arch

skeleton, will delight all connoisseurs of the elegant in fossils) and by serial sectioning, helped by the use of alizarin to differentiate bone from matrix. The adult bony neural endocranium, which consists of two unpaired bones, develops from a number of paired and unpaired ossifications; this observation may help to explain conditions in higher Actinopterygii. The cranium is exhaustively discussed; the brain and cranial nerves and vessels can be very fully reconstructed. The membrane bones of the basis cranii and palate, and the whole visceral skeleton, are so well preserved that much earlier work is shown to be erroneous, and new problems are posed. The dermal bones of the outer surfaces of the head are known in great detail; their mutual overlap and their relations to the latero-sensory canals and pit-line grooves are fully discussed. Several interesting problems of terminology are raised. A separate quadrato-jugal is present (but not in *Boreosomus*, where Nielsen allows the possibility of its complete reduction). Elsewhere the compound terminology characteristic of the Swedish school is in evidence: for example, supratemporo-intertemporal, supra-orbito-dermosphenotic, supraorbito-postorbital and lacrimomaxillary. While these names may give a good idea of topographical extent, they imply a fusion of bone rudiments; in many cases other explanations are possible, and even likely. The axial skeleton is fully described, and shows the expected agreement with *Acipenser*. The endoskeletal shoulder-girdle is very completely known; the pectoral fin must have been a nearly horizontal keel. In the pelvic skeleton, a short metapterygial axis may be present. *Glaucolepis* is undoubtedly a close relative of *Palæoniscus*, and is referred to the family Palæoniscidæ (s.s.).

Boreosomus differs in several respects from *Glaucolepis*; the endocranium is not so fully described, since serial sectioning was not completed. The pattern of the dermal bones, the body-shape, position of fins and scale-ornamentation indicate relationship to the 'palæoniscoid' family Acrolepidæ, to which Nielsen refers *Boreosomus*. But the reduced body-lobe does not quite reach the tip of the caudal fin; this is a feature characteristic of the grade 'Sub-Holostei', as defined by Brough, and *Boreosomus* forms an excellent bridge between the Acrolepidæ and the sub-holostean Ptycholepidæ. On balance, *Boreosomus* should probably be referred to the latter family. The base of the pectoral fin is almost vertically placed, and this change from what seems to be a generalized 'palæoniscoid' structure is a big step towards the higher Actinopterygii, possibly associated with the reduction of the body-lobe of the caudal fin, as I have suggested elsewhere.

This work emphasizes almost too pointedly a trend with grave implications for British palæontology. A number of highly skilled preparators, photographers and illustrators collaborated, as in all the other great works produced by Stensiö's school. In many American institutes similar facilities are commonly available. In most British laboratories and museums such technical staff is practically non-existent or hopelessly overworked, and a great mass of fossil treasure in our museums is in wait for full discovery. The same is true in other studies; there are departments without even the facilities for preparing thin sections of rocks and fossils. The training and wider employment of skilled technicians is one of the greatest needs of British science.

T. STANLEY WESTOLL

INSTRUMENTS IN PRESENT-DAY SCIENCE

Major Instruments of Science and their Applications to Chemistry

Edited by R. E. Burk and Oliver Grummitt. (Frontiers in Chemistry, Vol. 4: Published under the auspices of Western Reserve University.) Pp. xii + 151. (New York: Interscience Publishers, Inc., 1945.) 3.50 dollars.

The Electron Microscope

Its Development, Present Performance and Future Possibilities. By Dr. D. Gabor. (Electronic Engineering Technical Monographs.) Pp. 104. (London: Hulton Press, Ltd., n.d.) 4*s*. 6*d*. net.

Scientific Instruments

Described by specialists under the Editorship of Herbert J. Cooper. Pp. 293. (London: Hutchinson's Scientific and Technical Publications, 1946.) 25*s*. net.

AT a luncheon of the Physical Society in Cambridge shortly before his death, Sir J. J. Thomson commented whimsically on the equipment needed in a present-day physical research laboratory. When he became Cavendish professor in 1885, he said, his annual allowance for equipment was never more than a few hundred pounds, but "nowadays they want all of that for a new magnet". It is indeed a commonplace that a very great part of present-day research in physics, and increasingly also in chemistry, relies on the use of elaborate equipment which, even had it been available, would have been quite beyond the means of university laboratories a couple of generations ago, when glass and string and sealing-wax, and silk-covered wire and adequate primary batteries, gave contemporary genius much of the material help it needed in exploring the unknown.

Since those days scientific work has undergone great expansion in the schools and universities, and now it is well on the way to permeating industry. Science is being used, and with that use there has arisen a vigorous scientific instrument industry providing measuring devices of increasing power and precision to a growing body of users willing, and more often able, to pay for them. One result of this is that measurements which formerly would have taxed the resources of the best-equipped laboratories are now made as a matter of daily routine; but added to this we have seen the development, largely in industrial research laboratories, of new instruments and techniques which in their turn are already making important contributions to our knowledge of fundamentals. Nowhere, perhaps, is this to be seen more clearly than in the fields of electronics and optics, with which the books under review are mainly concerned.

"Major Instruments of Science and their Applications to Chemistry" is based on a series of lectures delivered by outstanding workers to mixed audiences at the Western Reserve University "as a mechanism for presenting to graduate students the flow of chemical research, and for keeping industrial chemists abreast of their science". Of the five contributors, it may be noted, three come from leading industrial concerns. Dr. L. H. Germer writes on electron diffraction, Prof. L. Marton on the electron microscope and its applications, Dr. M. L. Huggins on X-ray diffraction, Prof. W. R. Brode on chemical spectroscopy and on absorption spectra, and Dr. R. Bowling Barnes on the infra-red spectrometer and its application. In each case the author's approach is elementary,

but the subject is developed, as smoothly as space limitations permit, to a stage where the power of the instrument in question in investigating physical and chemical structures, whether for the purposes of research or identification, is clearly brought out. The result is a slim but eminently readable and stimulating volume which should succeed notably in its object.

A few examples will illustrate the extent to which the articles reflect the more valuable trends in present-day technique with these instruments. Brode, in dealing with chemical spectroscopy, summarizes the so-called internal-standard method, whereby a comparison of the densities or transmissions of groups of neighbouring spectral lines due to two elements, one of which may be regarded as the 'unknown', gives a direct measure of the unknown without recourse to a specific plate calibration, provided the excitation conditions of the source are sufficiently stable and the comparison lines are carefully chosen. Again, Barnes shows how the infra-red spectrum of a pure compound, being unique, 'fingerprints' the molecule and so permits its rapid identification; while Huggins gives examples of the fascinating photographic methods (for one of which he was himself responsible) which are now being used to build up trial models of crystals the X-ray diffraction spectra of which are known. The articles include bibliographies which will be found useful by readers approaching the subjects for the first time and which, in Marton's article for example, will be of value also to the expert.

Dr. Denis Gabor's little book is in rather a different category. It forms the third of a series of monographs published by the Hulton Press, and publishers and author alike are to be congratulated on having produced, at a very modest price, a most useful addition to the literature of a subject which, though it has reached a sturdy adolescence, lacks as yet an adequate literature in book form. Dr. Gabor's treatment is systematic, approaching the elements of geometrical electron optics by way of the Hamiltonian analogy between the path of a particle in a conservative field and that of a light-ray in a refracting medium. After describing the simpler aberrations to which electron lenses are subject, he discusses the origin of contrast in the electron microscope, showing in particular the part played by spherical aberration even when electrons are inelastically scattered by the object and 'chromatic' aberration is therefore absent. This naturally leads to a consideration of resolution and detection limits in the present-day instruments, which lie in the region of 10–20 A. The principal instruments are then described, together with the techniques of specimen-preparation and some of the more striking results. This straightforward account receives added value from a series of chapters, forming the final one-third of the book, devoted to possible future developments and to the ultimate limit of electron microscopy. Here the author has himself made noteworthy contributions and the book has in consequence the unexpected air of a research record rather than a review. The book is not dated and there are minor awkwardnesses of expression and misprints (notably, on p. 16, where 0·001 in. is said to equal 40,000A.), but these, it is hoped, will be rectified in future editions.

"Scientific Instruments" is intended for a much wider circle of readers than either of the foregoing works. Fifteen contributors have produced some thirty chapters, each dealing with a different type of instrument, and the editor has had the unenviable task of arranging the mass of material in such a way as to give a balanced picture which shall appeal at once to scientific workers out of their own special fields and to intelligent laymen. The result is not altogether happy, and the reader may feel with the reviewer that the very breadth of the objective is responsible for this, though much could have been done to improve the balance of the work. For example, it is doubtful whether a reader able to appreciate the clear but condensed account of mass spectrographs on pp. 90–94 would require to be given (on p. 154) wordy formulæ on the relation of the Fahrenheit to the Centigrade scale of temperature: nor would he be content with the determination of the upper fixed point of a thermometer by immersing it "in steam from boiling water". Other examples of the same sort could be given; examples, too, of duplication (as between the chapters on "Pressure" and on "Barometer, Barograph and Altimeter"). Electrical instruments, on the other hand, receive scant treatment, a chapter on moving-iron and moving-coil instruments being widely separated from a brief account of electronic devices, which is deposited next to calculating machines in a final section having the heading "Miscellaneous". Yet with it all the book is on the whole well produced and extremely well illustrated, and if used with care will serve as a handy work of reference. It is to be hoped, therefore, that it will have a sufficiently wide appeal to warrant later editions in which its defects of arrangement and presentation may be remedied and the whole properly indexed. L. V. CHILTON

FLOUR MILLING

Flour Milling

By J. F. Lockwood (assisted by Anthony Simon). Pp. 511. (Liverpool, London and New York: Northern Publishing Co. Ltd., 1945.) 25*s*. net.

PERHAPS nobody is better qualified than Mr. Lockwood to write an up-to-date treatise on flour milling. Apart from his own qualifications and experience, he is a director of the firm of Henry Simon, Ltd. and thus able to draw upon the wealth of technical knowledge available within that large organisation.

Flour milling is first and foremost a craft. The university may turn out an engineer in three years and a physician and surgeon in five, but the milling student requires a very much longer apprenticeship before he can graduate as a miller. Fortunately, the scientific worker in an industry need not be, and rarely is, one of its craftsmen, and for such outsiders, Mr. Lockwood has written an introduction entitled "A Simple Outline of Flour Milling" which is a masterpiece of condensation and invaluable to the research worker who wishes to acquaint himself with the broad principles of the flour milling process.

The introduction of the man of science into any industry sooner or later upsets any tranquillity it enjoys, and flour milling is no exception. Good colour and baking quality are no longer the only prerequisites, and the miller is now equally concerned about the vitamin B_1, calcium, fibre contents, etc., of his flour. Milling is rapidly becoming a highly selective process with as much emphasis on what should be included in the finished flour as excluded. For its type, the book contains a good account of recent developments in the nutritional field together with the preliminary engineering steps that have to

be taken to keep pace with them. Flour milling certainly promises to be an outstanding biological-engineering process, and when it is realized how much of this biological work has been carried out in the last decade it may well be that before long flour milling as we know it to-day will be radically altered. In any event, the 1960 edition of Mr. Lockwood's book should call for much revision.

The book is well produced and the figures and diagrams are of a high standard. It occupies some five hundred pages including thirty-eight well-balanced chapters; historical detail, more the concern of specialized works, is quite rightly omitted. There is an excellent survey of wheat characteristics and testing, including a scientific analysis of the subjects of wheat cleaning and screen-room separators, particularly in regard to the use of air currents. The conditioning of wheat is discussed in detail, and this chapter includes a useful account of the heat relations of various commercial dryers and conditioners. A series of chapters describes the principles of grinding and sifting and the main divisions of milling—breaking, grading and dusting, purification and the scratch and reduction systems; each is lucid and authoritative. The last five chapters deal with the mill management and costs. Finally, there are a number of appendixes, which will interest the mathematical physicist, as well as a glossary of milling terms in different languages.

This first-class and most stimulating book should be the *vade mecum* of every miller, milling technologist and the cereal chemist who wants to know and understand the practical implications of his work.

T. MORAN

FROST DAMAGE TO FRUIT TREES

Frost and the Fruitgrower

By Raymond Bush. Second edition. Pp. viii + 119 + 23 plates. (London, Toronto, Melbourne and Sydney: Cassell and Co. Ltd., 1946.) 10*s*. 6*d*. net.

THE British fruit crop of 1945 was very seriously curtailed by severe frost damage, and many parts of the country have experienced similar trouble in the present season. Mr. Bush shows in this volume that the fruit yield of England and Wales varies from the average by nearly 300 per cent, as against 30 per cent in the United States, 37·5 per cent in Canada, and 17 per cent in Australia. The causes of this large variation are not fully understood, but damage by frost must be important. These facts assault the whole structure of home fruit production, and in a generation much less content to accept 'acts of God' than formerly, it is natural to inquire what can be done to mitigate the trouble.

Mr. Bush's book supplies at least a partial answer to these problems. He reviews many aspects of the problem, chiefly those relating to radiation frosts. It is now well established that damage from such frosts can be minimized by the avoidance of 'frost holes' for the establishment of orchards, the use of certain planting methods, and the modification or elimination of barriers to air drainage. 'Frost holes' are low-lying areas which receive and retain cold air collected from a wide region. The most suitable frost-free sites are gentle slopes with good drainage of cold air from below the orchard. Wind-breaks, hedges, and the fruit trees themselves all impede this downward flow of cold air. Hedges can be replaced with netting; wind-breaks can be cleared at the base, while trees should be planted at about the rate of one hundred per acre. Standards should be planted at the base of a slope, with bush trees at the top. All this is portrayed with a clarity of text, simple diagram and photograph which should appeal to the practical grower.

The author has performed a great and timely service to British fruit growers. He has interpreted adequately all the knowledge of frost damage control which can at present be applied in practice. Frost damage in the Clyde Valley in 1945 and 1946 does not, however, fit completely into the picture he has painted. There is the additional factor of wind, acting apart from katabatic flow. Research has, however, now been directed to this and other outstanding matters of frost damage and control. The author is only at the mercy of time as the fourth dimension in this respect. The enlightened practice of his present conclusions would go far towards a solution of the problem of frost damage.

The volume also deals with phenology in relation to frost damage, thus involving varietal effects. It figures various types of frost damage to blossom and to mature fruit. Methods of forecasting frost are considered, and would form the basis for future trial. Orchard heating is discussed, not as a finite method of control, but as a useful possibility in certain topographical situations. The book is an intelligent evaluation of present knowledge upon the subject, and research workers have already accepted the challenge to fill the gaps revealed by Mr. Bush's text.

JOHN GRAINGER

SOME COLEOPTERA OF FRANCE

Faune de France

44: Coléoptères Bruchides et Anthribides. Par Adolphe Hoffmann. (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. 184. (Paris: Paul Lechevalier et fils, 1945.) 250 francs.

WE welcome the appearance of another instalment of the Faune de France series of monographs. The present contribution deals with five small groups of Coleoptera which the author regards as constituting separate families. The most important of these are the Bruchidæ, which comprise seven genera and sixty-eight species within the faunal limits of France. The Anthribidæ are represented by six genera and twenty-one species. The genus *Urodon*, which has long been attached to this family, is placed by M. Hoffmann in a separate one of its own—the Urodonidæ, transitional between the Rhynchophora and Phytophaga. Some modern authorities, it may be added, relegate it to the Bruchidæ. Five species of the genus are included in the French fauna. The Brenthidæ also come in for consideration. They comprise but a single French species *Amorphocephalus coronatus*, which lives in association with ants of the genus *Camponotus*. Finally, a separate family—the Nemonychidæ—is erected to replace the tribe Rhinomacerini of the Curculionidæ. It is considered transitional in structure between the last-named and the Scolytidæ. Three genera, each with a single species, are included within the faunal limits. The work, as a whole, is well up to the standard of its predecessors; it is adequately illustrated, the figures of the species of Anthribidæ being particularly effective, and there is the usual compendium of diagnostic keys to the genera and species dealt with.

A. D. IMMS

Collected Papers on Metallurgical Analysis by the Spectrograph

Edited by D. M. Smith. Pp. xi + 162. (London: British Non-Ferrous Metals Research Association, 1945.) 21*s*.

THIS volume comprises a representative selection made by Mr. D. M. Smith of papers submitted to the spectrographic panels set up by the British Non-ferrous Metals Research Association. The result of this selection is a volume from which spectrographers may derive helpful guidance in the correct choice of analytical methods for the routine examination of aluminium, lead, zinc, copper and platinum and their alloys. Photographic plate calibration and processing have also not been overlooked.

Special mention should be made of the contribution from the laboratories of the British Aluminium Company, Ltd., on the analysis of aluminium and its alloys. This paper is much more comprehensive than most of the others which are included in the volume, and the results are likely to be as valuable to spectrographers dealing with the analysis of aluminium alloys as the work of Barker and his collaborators has been to those dealing with the analysis of steels.

The reviewer has noted that nearly all of the work reported has been carried out with conventional D.C. arc and condensed spark circuits. This emphasizes the fact that while much attention has been given to variations due to metallurgical sampling and to photographic techniques, by no means so much attention has been given, in spectrographic work in Great Britain, to the other major source of inaccuracy, namely, the spectrographic source. The investigation of source characteristics forms one of the terms of reference of the General Research Panel of the B.N.F.M.R.A., and the reviewer feels that the value of the present volume would have been considerably enhanced had it been possible to include reports on work within the scope of this Panel, which has no significant representation in the book. A. H. S.

Qualitative Inorganic Microanalysis

A Short Elementary Course. By Ronald Belcher and Dr. Cecil L. Wilson. Pp. viii + 68. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 2*s*. 6*d*.

THE authors of this small text-book believe that the adoption of micro-methods of qualitative analysis would be furthered if the subject could be presented in a simple way which would enable junior students to take up the method with a minimum of special apparatus and with a possibility of success. Most of the apparatus required, apart from a centrifuge, can be made by the student, suitable directions being given. Modern tests and separations are described, and the instructions are clear and adequate, no theory being introduced. The course can be regarded either as supplementary to a normal course of qualitative analysis, or as providing first instruction in the latter, when it may be reckoned to occupy a twelve weeks course of three hours a week. The apparatus is illustrated by clear and effective diagrams, and schemes for routine analysis are given.

All teachers interested in micro-analysis, whether in school or more advanced laboratories, will find this a useful and interesting book, and the subject is one which young students will probably find attractive. One of the troubles of the teacher of qualitative analysis is the tendency to dirty and untidy work in the laboratory, and it is certain that the use of micro-methods would put an end to this. The training would be valuable, and altogether the authors seem to have made out a good case for the use of such methods as standard practice. The book is well printed and bound in limp covers, and the price is very reasonable.

The Adventure of Youth

The Psychology of Adolescence and its Bearing on the Extension and Reform of Adolescent Education. By Dr. Olive A. Wheeler. Pp. ix + 212. (Bickley: University of London Press, Ltd., 1945.) 6*s*. net.

IN planning extensions and reforms of adolescent education, most local education authorities have become fully aware that they can only be prepared by exact knowledge and sympathetic understanding of the needs of youth. In this book, which is an extension of and natural successor to her earlier work on this subject, Prof. Wheeler surveys the characteristic developments of, and variations among, adolescents. A careful survey is made of existing provisions for adolescent education and the service of youth in Britain, and the extensions and reforms which are now projected are treated to a critical examination based on facts built up during the author's long experience in this field. Internal problems like those of the curriculum, educational and vocational guidance, methods of discipline and teaching, and the religious and moral education of adolescents are also subjected to close scrutiny, and means of solving them are suggested. Like its predecessor, this valuable book supports the view that Prof. Wheeler is one of our foremost authorities on the education of the adolescent. T. H. HAWKINS

Friends in Fur and Feather

By Frances Pitt. Pp. 208+49 plates. (London: *Country Life*, Ltd.) 12*s*. 6*d*. net.

A NEW book on animals by Frances Pitt needs little more by way of comment than bringing it to the attention of all who have read her earlier stories of animals. This one, the story of all her many pets over many years, is worthy to take its place with any she has written because it offers so much to the animal-lover and not a little to the student of animal behaviour. At this stage of the peace it may be a little ungracious to complain of the production itself. Yet Frances Pitt has written such a delightful book, which will long find a place on many shelves, that it seems a pity better paper could not have been found for the text. The photographs, taken by the author, are, on the other hand, well produced.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1946

Edited by Arthur J. Dalladay. Pp. 412 + 31 plates. (London: Henry Greenwood and Co. Ltd., 1946.) 3*s*. 6*d*. net (paper), 5*s*. net (cloth).

THE latest edition of this well-known almanac carries all the features which have made it so useful in the past—features such as tables and formulæ, legal and commercial information and very full advertisements of current materials and apparatus—but continued paper shortage has limited a number of sections. J. Allan Cash, whose work for the British Council is well known, writes on "Industrial Photography with Miniature Cameras", while other contributed articles of interest to readers of *Nature* are "The Photography of Lepidoptera", by Edward Richardson, and "Films for Children in Education and Entertainment", by Mary Field.

THE ROYAL GREENWICH OBSERVATORY

By Sir HAROLD SPENCER JONES, F.R.S.
Astronomer Royal

WHEN Charles II decided in 1675 to found an observatory for "rectifying the tables of the motions of the heavens, and the places of the fixed stars, so as to find out the so-much desired longitude of places for the perfecting the art of navigation", he provided a site in the Royal Park at Greenwich, "upon the highest ground, at or near the place where the Castle stood". Sir Christopher Wren was appointed architect of the observatory, and the pleasing building which he designed "for the observator's habitation and a little for pompe", as he wrote in one of his letters, still stands, a symbol of the continuity between the observatory of to-day and the observatory of 1675.

Greenwich was a pleasant village in open country, several miles from London, when it was selected as the site for the Royal Observatory. But London has gradually grown outwards until it has entirely surrounded the Observatory, and the conditions for astronomical observations at Greenwich have become progressively more and more unfavourable. The first serious menace to the work of the Observatory came in 1905, when the London County Council erected a power station for its tramway system on the Greenwich meridian, immediately to the north of the Observatory, and adjacent to the noble buildings of Greenwich Hospital, occupied by the Royal Naval College. Such callous disregard of local amenities by a public authority would be less likely to happen nowadays, when the public conscience is fortunately more alive to the need for the preservation of amenities, which are of concern to the nation as a whole.

The impurity of the atmosphere at Greenwich and the increasing brightness of the sky at night, caused by brighter street lighting, have been so detrimental to the observational work that the removal of the Observatory from Greenwich had to be faced, if the Observatory were to be able to continue to make contributions of value to observational astronomy. Thus, for example, the non-uniform and variable transparency of the sky has made any type of photometric work impossible, while the brightness of the sky has put the installation of modern equipment, with great light grasp, out of the question. The matter was brought by the Astronomer Royal to the attention of the Board of Visitors of the Royal Observatory in 1938. Since then, extensive search for a new home for the Observatory, where conditions are favourable for observation, has been made. It was recently announced by the Admiralty that Herstmonceux Castle in Sussex had been selected, in consultation with the Board of Visitors, as the most suitable of a number of possibilities. Along with the Castle, some 370 acres of ground are being acquired for the erection of the instrumental equipment and as a safeguard against the encroachment too near the Observatory of any buildings which might prove detrimental to the work.

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HERSTMONCEUX CASTLE: SOUTH AND EAST FRONTS

Herstmonceux Castle was built by Sir Roger de Fienes, treasurer to the Household of Henry VI, who in 1441 obtained a licence to "enclose, crenellate, and furnish with towers and battlements his manor of Herst Monceux". The Castle was built in brick of a mellow red colour, the bricks being almost certainly of local origin. Brick was still at that time largely an alien material; there are no important brick buildings south of the Thames earlier than Herstmonceux, which is probably not only the finest

early brick building in England but also the most beautiful of English baronial buildings. The mouldings and dressed work are for the most part executed in stone, a greensand, which gives great sharpness of detail and which has weathered well.

After 1740 the Castle fell into neglect, and in 1777 the interior, including the buildings in the court within the main rectangular structure, were demolished and the materials used to build the mansion now known as Herstmonceux Place. Little remained of the original fabric beyond the outer walls, with their towers, and portions of the inner walls. In 1911 the Castle was purchased by Colonel Claude Lowther, who commenced the restoration. After his death it was acquired in 1932 by Sir Paul Latham, Bart., under whose direction the restoration was completed by Mr. W. H. Godfrey. The outer walls and towers were carefully repaired and restored to their original condition; the ivy was removed from the walls; and the moat, on the east, south and part of the west fronts, was refilled with water. The reflexion of the Castle in the water of the moat, emphasizing the vertical lines of the towers, adds greatly to the beauty and impressiveness of the Castle.

The situation of the Castle was thus described by Francis Grose ("Antiquities of England and Wales", 5, 157–8), a century and a half ago:

"The Castle of Herstmonceux stands in a pleasant park, well diversified by hill and vale, finely wooded with old trees, and well watered by clear pools, and from it there is a fine view over the adjacent rich level of Pevensey (in the midst of which, on a little rise, is the town and ancient ruined Castle of Pevensey). The sea appears in front, southward of the hills towards Hastings to the east; and the South Downs rise mountain-like at some distance to the west. The Castle is seated near the southern edge of the park, and rather in the lowest part of it; the soil is, however, very dry."

In this noble and dignified castle, rich with historical associations, the Observatory will in the future find a home befitting its long traditions. In the grounds which have been acquired surrounding the Castle there is ample space for setting up the present instrumental equipment and future additions to it. The conditions for astronomical observation are about as good as can be found in England and, freed from the hampering conditions under which it has worked for many years, the Observatory will have new opportunities for making contributions of importance to the promotion of astronomical science.

Because of the long association of the Observatory with Greenwich and the selection in 1884, by international agreement, of the Greenwich meridian as the prime meridian of longitude, in recognition of the great contribution of the Observatory to astronomical and nautical science, the Royal Observatory will be known in its new site as the Royal Greenwich Observatory. The Observatory will no longer remain on the prime meridian, but there will be a sufficient overlap in observations at Greenwich and at Herstmonceux for the longitude of the new site to be determined with the necessary degree of accuracy.

The Nautical Almanac Office, which it has not been possible to accommodate with the observational departments of the Royal Observatory on the restricted site at Greenwich, will also be housed at Herstmonceux Castle. The closer association between the observational and computational branches of the Royal Observatory, which will thus become possible, will be to their mutual advantage.

A THEORY OF CHROMOSPHERIC FLARES

By R. G. GIOVANELLI

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IT has been established from observation that chromospheric flares are closely associated with sunspots, and that the probability of a flare occurring near a spot increases with the size of the latter. The probability is higher when the group is increasing its size than when it is stationary, and it is also higher for the magnetically complex $\beta\gamma$- and γ-groups than for the simpler α- and β-type groups[1]. The flares themselves are short-lived phenomena, of mean life about thirty minutes, and are quite localized. It is generally accepted that they show no velocity either in height or across the surface of the sun.

A mechanism is proposed here for the production of these flares based on the energies acquired by charged particles moving in induced electric fields associated with sunspots.

Strong magnetic fields exist in sunspots, and there is a large magnetic flux from the spots. It is usually agreed that the field due to a spot extends to an appreciable distance from it[2]. During the growth of a sunspot, there must be electric fields induced in its neighbourhood, and if the axis of the spot be vertical, the lines of electric force will be circles coaxial with the spot and parallel to the sun's surface. The magnitude of the electric field at a given point will depend not only on the rate of growth of the spot, but also on the conductivity of the surrounding medium. The existence of a magnetic field away from the spot, however, indicates that the conductivity does not prevent the magnetic field from being established in a time at least comparable with that required for the spot to grow. It is reasonable, therefore, to compute the magnetic and induced electric fields for a surrounding medium of zero conductivity and apply these results to determine the order of magnitude of the actual fields; provided that polarization charges do not become serious.

For a sunspot growing uniformly, in 50 hours, to a diameter of 7×10^8 cm., that is, one-hundredth of that of the sun, and a maximum magnetic field of 2,000 gauss, the magnetic and induced electric fields may be computed by treating the sunspot as a circular coil of the same radius carrying a current such as to produce, at any time, the same axial magnetic field. The electric and magnetic fields, which are mutually perpendicular, are given below for radial distances, in the plane of the coil, 2·5 and 5 times the spot radius, that is, in the region where flares frequently occur.

Distance from centre of sunspot (cm.)	Magnetic field (gauss)	Electric field (volt/cm.)
3.5×10^9	8	1.55×10^{-3}
1.75×10^9	64	6.2×10^{-3}

Chapman and Cowling have shown[3] that, in crossed electric and magnetic fields, charged particles undergo a drift which has a component velocity in the direction of the electric field amounting to

[illegible]

where τ is the mean time between collisions and ω is eH/m.

Considering the motion of electrons in these fields, they will on the average acquire energy between collisions, and if this be greater than the loss due to elastic collisions, which with hydrogen atoms is about one-thousandth of the electron energy, the average energy will increase until excitation of the atoms can occur. The increase of energy will be much less with protons, owing to their greater mass, and they are therefore afterwards neglected.

For an electron to acquire energy equal to the first ionization potential of hydrogen atoms it can be shown that

$$\frac{E^2\lambda^2}{1 + 8\cdot 8 \times 10^{-3}H^2\lambda^2} \geq 2 \times 10^{15},$$

where λ is the mean free path and E is in E.M.U., so that if $H = 0$, then $\lambda \geq 4\cdot 5 \times 10^7/E$. If E is 10^{-3} volt./cm., that is, 10^5 E.M.U./cm., then $\lambda \geq 450$ cm.

This discussion has neglected the distribution of velocities about the mean, so that, clearly, some excitation of hydrogen atoms will take place for shorter mean free paths than given above. When Cillié and Menzel's results for electron distribution in the chromosphere[4] are combined with Cowling's figures for cross-sections of protons[5], it is found that a mean free path of 450 cm. occurs about the middle of the chromosphere, some 6,000 km. above its base. If the induced field exceeds the above value, then the excitation occurs down to lower levels in the chromosphere.

If, in the equation above, $8\cdot 8 \times 10^{-3} H^2\lambda^2$ is large compared with unity, then $H \leq E/1\cdot 32 \times 10^6$ and for the same value of E as above $H \leq 7\cdot 5 \times 10^{-2}$ gauss. Thus excitation can occur with mutually perpendicular electric and magnetic fields only if the magnetic field is very small, and it is of interest to see whether such conditions can exist in the chromosphere.

The presence of a general magnetic field on the sun was announced by Hale in 1913, its magnitude being given as about 25 gauss. While there is still some doubt expressed as to the actual existence of the field owing to its small size, recent measurements by Thiessen[6] confirms its reality.

Apart from a general magnetic field, fields from other sunspots may still be of appreciable size in the neighbourhood of the spot under consideration. It is thus to be expected that there will be places where actual neutral points exist and where conditions are thus suitable for the excitation of atoms by collision.

It is not essential that the magnetic field be small for electrons to acquire high energies : this is only the requirement so long as the electric and magnetic fields are assumed to be mutually perpendicular. If, owing to an external magnetic field, the electric field has an appreciable component in the direction of the resultant magnetic field, the electrons will have a component of their drift velocity in that direction, and this component will not be affected by the magnitude of the magnetic field.

In the above discussion, polarization charges have not been considered, and it remains to be shown whether they can influence the electric field to a significant extent. Cowling[5] has developed equations giving the conductivity of the material in the sun's atmosphere in the form

$$\sigma^{I} + i\sigma^{II} = \{6\cdot 8 \times 10^{13}\bar{Z}T^{-3/2} - i\, 8\cdot 6 \times 10^3 HT/\rho_e\}^{-1} \text{ E.M.U.},$$

where σ^{I} and σ^{II} are the direct and transverse conductivities [illegible] ally perpendicular electric and magnetic fields, $\bar{Z}$ is the mean degree of ionization, T the (electron) temperature and ρ_e the electron pressure. Throughout the chromosphere the direct conductivity is of the order of 10^{-8} E.M.U. for very small magnetic fields, while for magnetic fields greater than $0\cdot 1$ gauss both conductivities are very much less, becoming negligible in comparison with the conductivity for zero magnetic fields and, for non-perpendicular fields, with the conductivity along the lines of force. Thus in the chromosphere, except near neutral points, electrons are constrained to move in the direction of the magnetic field. However, in and below the reversing layer, conditions are such that magnetic fields of the order of hundreds of gauss will have little effect on the conductivity, owing to the much higher electron pressure.

If the external magnetic field be inclined to the surface, the neutral point will be either higher or lower than the spot, according to the direction of the external field and the polarity of the spot. If the neutral point be in the chromosphere, then electrons moving away from this point under the influence of the electric field will eventually reach a region where the magnetic field is strong enough to confine movement to the lines of force. These lead down to the reversing layer where the conductivity is high enough to prevent the accumulation of space charges.

Along lines of force which pass into the sunspot, the question of the magnitude of any space charges which may be built up in these regions depends at least in part on whether currents will flow transversely through a sunspot. It is not necessary, however, to indicate here whether or not this is the case, as any polarization fields built up in these regions will tend to increase rather than decrease the electric intensity in the neighbourhood of the neutral point, and thus cause no blockage to the mechanism. A similar result follows from any space charges due to the movement of electrons along the lines of force of the external magnetic field.

The above discussion has shown that it is possible to have localized regions in the chromosphere where electrons acquire sufficient energy to cause excitation of atoms by collision, and where there will thus be an increase in the radiation emitted. Many of the features associated with this radiation—its elevation in the chromosphere, location with respect to spots, stationary nature and association with changing sunspots—are similar to those of chromospheric flares, and it is therefore suggested that the above mechanism is responsible for these flares.

The transient nature of the flares may have several explanations. It may be due to temporary increases in the rate of growth of a spot, or to changes in the magnetic field, for example, location of neutral points, in the vicinity of a spot.

Similarly, the more frequent occurrence of flares in γ- than in β-groups may be attributed to either the greater number of suitable locations, such as neutral points, which must occur in these groups or greater fluctuations in the individual spots which make up the group.

The implications of the mechanism proposed above will be discussed in greater detail elsewhere.

[1] Giovanelli, R. G., *Astrophys. J.*, 89, 555 (1939).

[2] Chapman, S., *Mon. Not. Roy. Ast. Soc.*, 103, 117 (1943).

[3] Chapman, S., and Cowling, T. G., "The Mathematical Theory of Non-Uniform Gases", 327 (Cambridge University Press, 1939).

[4] Cillié, G. G., and Menzel, D. H., Harvard College Observatory Circular 410 (1935).

[illegible] Cowling, T. G., *Proc. Roy. Soc.*, 183, 453 (1945).

NITROGLYCERINE AND GUN-COTTON: A DOUBLE CENTENARY

By Dr. J. WEIR
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A HUNDRED years ago there occurred a striking double event, the consequences of which could scarcely have been foreseen, even by the most imaginative visionary of the time: Ascanio Sobrero, professor of chemistry in Turin, discovered nitroglycerine, the basis of many modern explosives, both military and industrial; and C. F. Schönbein, professor of chemistry at Basle, discovered guncotton, which has also exerted a profound influence on the explosives industry, not only because of its military applications, but also as the forerunner of other similar nitrocelluloses which have had enormously wide applications in peace-time industries.

Nitroglycerine

Sobrero described the salient properties of nitroglycerine (which he called 'piroglycerina', and which is more correctly designated glycerine trinitrate), but it remained more or less a laboratory curiosity until Alfred Nobel turned his attention to it in the early 1860's. He and his father, Emmanuel, had been experimenting with nitroglycerine for some time, and like all the early experimenters with this dangerous liquid, had encountered several major difficulties in purifying, handling and transporting it. In 1863 the Nobels set up a new laboratory near Stockholm, and started a brilliant series of researches on methods of manufacture and of initiating and controlling the explosion of nitroglycerine. They also began to produce the explosive on a fairly large scale; but a serious explosion wrecked their laboratory, killing Nobel's younger brother and four others, and brought on his father a paralytic stroke, from which he never fully recovered. Thereafter, Nobel was prohibited by the Swedish Government from manufacturing nitroglycerine near the city, but he had such an abounding faith in his product and his methods that he hired a barge, anchored it in a lake two miles from Stockholm and carried on.

Nobel made four major inventions in connexion with nitroglycerine, three in the industrial field and one in the military field.

(1) He made the transport and use of nitroglycerine immeasurably safer by absorbing it in a light earthy substance called kieselguhr to produce the well-known 'dynamite'.

(2) He found that nitroglycerine could not be readily initiated or exploded by application of a flame, as ordinary black-powder could. He discovered, however, that by enclosing a sensitive explosive, such as fulminate of mercury, in a metal tube or capsule embedded in the nitroglycerine or dynamite, the whole mass could be brought to detonation by setting off this tube, or detonator as it is now called. Owing to the very much increased speed of this detonation phenomenon compared with that of the rapid burning of black-powder, a source of power of a magnitude hitherto unknown became available for man's use.

(3) He found that collodion (a form of nitrated cotton) dissolved in nitroglycerine to form a semi-solid jelly-like mass, and thus gave to the world its most powerful industrial explosive, 'blasting gelatine'. The story goes that one day Nobel cut his finger, and, in order to form a protective coating for the wound, he applied some collodion solution. The pain of the wound kept him awake at night pondering the problem of getting a more active absorbent for nitroglycerine than the inactive diluent kieselguhr. It occurred to him that collodion, which was a nitrated product from cotton, chemically not unlike nitroglycerine, might serve the purpose. He went to his laboratory, tried out the experiment, and to his intense satisfaction found his fondest hopes realized.

(4) His fourth and in some ways his most astonishing achievement was the invention of 'ballistite'. His study of celluloid led him to try the replacement of the camphor therein by nitroglycerine. He thereby obtained a colloidal mass which he found suitable as a propellent explosive. That two violent and detonable explosives, such as nitroglycerine and nitrocellulose, could be combined to form a propellant of controlled rate of combustion seemed almost impossible; but Nobel did not seem to have the word 'impossible' in his vocabulary. His dauntless courage and fertile imagination, born of genius and the clear flame of science, places him in a position of undoubted supremacy amid the great master minds in the modern explosives industry.

As a result of the Nobel inventions, a new world industry started, and dynamite factories sprang up all over Europe and America during the 60's and 70's of last century. In Great Britain he was personally associated with the setting up of the Ardeer Factory in Ayrshire, which has grown to be one of the largest explosives factories in the world and is now under the control of Imperial Chemical Industries, Ltd.

The advent of these powerful nitroglycerine explosives, which owing to their high velocity of detonation were able to produce effects of a different order of magnitude from those obtained by the centuries-old black-powder, gave a tremendous impetus to the industrial revolution which was already in full blast. The enormously increased power, made available in a usable and easily transportable form, not only diminished the time required for many engineering works, but also enabled man to undertake projects which owing to his previous physical limitations were considered impossible. These explosives have multiplied his resources and cut down costs by their greatly increased yields over manual labour in the winning of ores and coal and in quarrying. As an instance of the laboriousness of previous methods depending on the pickaxe, the hammer and the wedge, it took, in the old days, 150 years to mine five miles of gallery in the Harz Mountains. By modern methods, utilizing high explosives, this work could now readily be done within five years. But for these modern high explosives, the building of highways, railways, canals, tunnels and aqueducts, the deepening of water-ways, the removal of obstructions to navigation, the clearing of forest or boulder-strewn lands, the reclaiming of swamps (all essential to our present state of civilization) would have been greatly restricted. The records of the discovery, manufacture, transportation and use of nitroglycerine explosives are replete with romance, and the wonder of it all has inspired many to refer to dynamite as the 'New Aladdin's Lamp'.

A few examples of the industries which have progressed amazingly as a result of the assistance of nitroglycerine explosives may be given.

Coal-mining, the largest section of the mining industry, shows a steep rise in the production curve during the fifty-year period ending 1920. This is

largely attributable to nitroglycerine explosives, the production curve of which followed a parallel course. The effect of the greater ease of production and increased output of coal on the iron and steel industries can scarcely be over-estimated. The limestone industry, second only to the coal industry in tonnage production, likewise owes a great debt to modern explosives.

The development of the electrical industry during the last few decades of last century was largely dependent on copper. The magnitude of that development would not have been possible unless modern high explosives had been available to blast out the copper ore economically in quantities hitherto unheard of. Similar developments took place in the mining of other metallic ores, such as those of lead, zinc, aluminium, nickel and silver; and it needs little imagination to visualize the tremendous impetus given to various industries when these metals became available in quantity at relatively cheap prices.

Reference must also be made to the gold-mining industry. The value of explosives to this industry is perhaps best shown in the gold mines of South Africa, the world's largest producing centre. Here the mining is all in deep deposits of metalliferous rock, and it is certain that but for the invention of modern high explosives it would have been impossible to tap economically this immense source of wealth.

The oil industry uses large quantities of nitroglycerine explosives, not only in the modern methods of searching for oil deposits, but also in the so-called oil-well 'shooting', where the explosives are employed to shatter the underground formation and thus open up fissures through which the oil may flow freely to the well.

It may thus be claimed that the advent of nitroglycerine and the development of modern explosives containing it, though not primarily responsible for the industrial revolution, played a leading, if not a decisive, part in making that revolution a complete victory over man's physical limitations.

In the foregoing, stress has been laid on the use of nitroglycerine in industrial explosives for constructive purposes, and to the amazing progress that has taken place in that field during the past century. This has been done intentionally, because, when the word 'explosives' is mentioned, the man in the street almost invariably thinks of the destructive effect of military explosives. While Alfred Nobel did not neglect the field of military explosives, as instanced by his invention of ballistite, he undoubtedly had much more prominently in his mind the potentialities of nitroglycerine for industrial purposes; his endowment of the fund to provide, among others, the Nobel Peace Prize, is evidence in this direction.

Guncotton

Guncotton was discovered in 1846 by Schönbein when he was investigating the action of nitric acid on cotton in the presence of sulphuric acid. Although this was not quite the first preparation of any nitrocellulose, since Pélouze had prepared an explosive from nitric acid and cotton in 1838, it was the first practical preparation, because Pélouze had omitted the very important step of including sulphuric acid in his mixture, and no practical results followed from his experiments.

Once Schönbein had made his discovery, it did not take long for developments to ensue. He came to Britain in the autumn of 1846, and gave very successful demonstrations of the new explosive. He took out a British patent for it, and entered into an agreement with John Hall and Sons of Faversham by which they were granted the sole rights of manufacture at their powder works. It says much for British enterprise that Hall's were so ready to take up the new and practically untried explosive, and one regrets that this enterprise met with such an unfortunate result. On July 14, 1847, there was a disastrous explosion which killed twenty-one workers and destroyed the factory. Other explosions occurred at Vincennes and Bouchet in France, with the result that manufacture was discontinued in France and Britain for a period of about sixteen years.

In the meantime, however, work was being carried out in Austria on improved methods of purification. Trials were carried out with guncotton as a propellant, as at this time the distinctive characteristics of the different classes of explosives were only very vaguely recognized, if indeed they were recognized at all. It was found that the explosive was so violent that the guns were liable to burst or to be seriously damaged. Finally, after several explosions of Austrian magazines in which guncotton was stored, the Austrian authorities decided to discontinue production of the explosive, and all further trials of it in Austria were stopped in 1865.

Even before this time, the memory of earlier disasters in Britain and France had faded, and von Lenk, who had been responsible for the work in Austria, was able to persuade the British and French authorities to take a renewed interest in guncotton as a military explosive. Manufacture was begun at Stowmarket, but was again unfortunately—but perhaps not unexpectedly from our present knowledge—interrupted by an explosion. Simultaneously, small-scale work was undertaken at the British Government's factory at Waltham Abbey, under the direction of Frederick Abel, and it was his classical researches which elucidated the conditions necessary to ensure the chemical stability of guncotton. This work may be said to have placed the whole production of this most important chemical on a sure foundation.

The essential feature of Abel's work was to show that, by the process of 'pulping', guncotton was produced in a form which could be much more readily purified than if such treatment were omitted. The impurities were comparatively easily removed by washing the pulped material. Thus, although the modern process of nitrocellulose stabilization and purification had not been quite reached, one of the most important principles, the thorough removal of acidic impurities from the finished product, had been laid down, and means had been evolved whereby it could be accomplished. The pulped form of Abel's guncotton was convenient for pressing into blocks, and these compressed charges were tried in guns. It was found, of course, that the material was still excessively violent in its action, and no satisfactory means could be discovered to control the violence of the explosion. The use of guncotton as a propellant was therefore abandoned.

However, considerable progress was made in the application of guncotton as a demolition charge, when it was found by Abel's assistant, E. A. Brown, that dry compressed guncotton could be made to explode very violently by means of a detonator containing mercury fulminate. This method had, of course, already been used by Alfred Nobel for detonating nitroglycerine, and is of fundamental importance. A further very important discovery, also made by

Brown, was that water-wet guncotton could be made to detonate by means of a small primer of dry guncotton, which had in its turn been set off by a mercury fulminate detonator. This arrangement was a considerable advantage from the military point of view, because it meant that the great bulk of the explosive could be transported and stored in a very insensitive form, and only after insertion of the sensitive dry guncotton primer was the material really hazardous, and then only if the primer itself were submitted to shock or friction. The foundations were thus laid for the production and use of guncotton as a military explosive.

During the years that followed, a vast amount of investigation was carried out on the subject of the nitration of cellulose. This work was by no means confined to the possible military applications of nitrocellulose. Every possible aspect of the new chemical was examined and tested, and the result was that an enormous and expanding field of application was found. It soon became apparent to the investigators that the so-called guncotton was only one of the possible products of nitration of cellulose, and that by varying the conditions of production, a wide range of products could be obtained. All these were, of course, nitrocelluloses, or, more correctly, cellulose nitrates; but they differed from each other in their nitrogen contents, in their solubilities in different solvents and in the viscosities of their solutions. These differences had a profound effect on the applicability of the different types of nitrocelluloses to the numerous uses which were to be discovered.

A range of nitrocelluloses was produced, having nitrogen contents from about 10 per cent to more than 13·4 per cent, and viscosities from a free-flowing 40 per cent solution to a stiff jelly in 3 per cent solution.

The nitrocelluloses were shown to be applicable, not only as military high explosives, but also, in admixture with nitroglycerine, as explosives for commercial blasting and special military applications; and also for the production of the propellants—cordite, nitrocellulose powder and smokeless shotgun powders. These examples are all in the explosives category, but the applications in other industries are no less extensive.

Quite apart from its explosive properties, nitrocellulose has special characteristics which render it unique in the chemical field. Its outstanding feature is to give, in combination with suitable plasticizers, hard and tough films and plastics. Celluloid consists of nitrocellulose and camphor, and is well known for its resistance to wear and to many chemicals. Nitrocellulose paints and lacquers have established for themselves a high reputation for quality and lasting properties. Leathercloth based on nitrocellulose is well known to be of high quality and reliability. Apart from these uses there are numerous other applications, including varnishes, adhesives and surgical uses.

Mention must also be made of Chardonnet's invention of a so-called artificial silk based on nitrocellulose, solutions of which were spun into fibres, which were then denitrated. His process has, of course, been superseded, but his work laid the foundations of a great and universally beneficial industry.

In this era of progress we leave behind the old and move on to the new, but at the moment the century-old nitroglycerine and military guncotton, with its industrial counterpart, are still well to the fore, and seem likely to remain so.

NUTRITIVE VALUES OF FOODS AND CONDIMENTS

At a meeting of the Nutrition Panel of the Food Group of the Society of Chemical Industry at Burlington House, London, on May 29, four papers, together covering the nutritive values of vinegar, pickles, condiments, margarine, edible fats, nuts and meat extract, were read to an appreciative audience.

Mr. H. S. Sarson opened by confessing that the attempt to assess "The Nutritive Value of Vinegar, Pickles and Condiments" put him on the horns of a dilemma: whether to emphasize analysis or cookery. Viewed analytically, the substances seldom show impressive results; nevertheless many are of high nutritive value. Vinegar, for example, is more than a digestive stimulant; it contains phosphorus, nitrogen and the B vitamins. Not only in Roman times, but also until a hundred years ago in Great Britain, fruit vinegars, sometimes flavoured and sweetened, were popular summer drinks.

Pickling, originally a method of preserving summer foods for winter use, was restricted to condimental use with the development of agricultural methods. But even to-day it is difficult to say whether *sauerkraut* and pickled herring are preserved foods (in both cases the nutritive elements are considerable) or just pickles. The food value of sauces, especially fruit sauces, is obviously high; normally, however (excepting predatory small boys!), one eats nutritively insignificant quantities per day. Salad creams are in a similar position, although in summer-time the daily intake may assume nutritive importance. Jams and preserves present an inverse example; normally contributing usefully to the diet, they are occasionally used purely as condiments (for example, red currant jelly with roast mutton).

Analytically, then, there is no strong case for the value of pickles, sauces, spices, etc., and deprivation would not cause deficiency diseases. Yet they have what it is not unfair to call essential roles in cooking throughout the world, in so far as a completely ungarnished diet would be grim and monotonous.

There is a curious specificity about 'the little more and how much it is', a peculiar 'just rightness' about, for example, chips *plus* vinegar, or pheasant *plus* bread sauce (and what is it that 'makes' bread sauce but the smell of onions and the taste of cloves?). Most efforts to alter, extend or shuffle such time-honoured combinations have failed, although new combinations are still being unearthed. Less than twenty-five years ago an American found that the best salad to accompany roast chicken is pineapple. One notes a semblance of orderliness about these combinations; for example, sharp sauces for fatty foods, sweet things with carbohydrates; and the general rule applies, the more highly flavoured the bulk food the stronger must be the condiment. Condiments are best regarded as nutritional catalysts, substances that may be (although by no means invariably) inert in themselves, but the presence of which renders food more appetizing and therefore more beneficial. Their place in the national dietary is of great importance.

"The Nutritive Value of Margarine and Edible Vegetable Oils" was then dealt with by Dr. H. Wilkinson, who began by grouping these food materials as follows: (*a*) oils extracted from oil seeds, then refined and deodorized, (*b*) the same oils hardened by hydrogenation, (*c*) blended oils as used in margarine

and cooking fats. Group (c) may be subdivided into (i) mixtures of a small amount of hardened fat in a preponderance of liquid oil (this yields a creamy product) and (ii) mixtures simulating in texture and analysis some natural product.

The commonest edible oils used in Great Britain are ground-nut, palm kernel, palm, cotton-seed, coco-nut and soya bean. Their nutritive value can be considered either purely in terms of available energy or, additionally, in terms of vitamins and essential fatty acids. If available energy is to be the sole criterion, we must, of course, assume that the diet is complete in all other respects. The controlling factor is then net absorption. Oils in group (a) (above), and moderately hardened oils (m.p. 32–42°C.), are absorbed to 96–99 per cent, while highly hardened oils (m.p. 46–48° C.) are absorbed to 91–94 per cent. The absorptions of mixed oils are usually the weighted means of those of the components, although certain blended and emulsified mixtures (for example, margarine) are better absorbed than the individual components. The fact that the vegetable oils normally used in Great Britain have net absorption figures higher than 90 per cent is satisfactory, in so far as it is unlikely that less than 10 per cent of unabsorbed fat will cause digestive disorders. The calorific value of all such oils falls within the range 8,100–9,100 calories per kilo.

Some oils, used more extensively outside Britain, are reported to have digestibilities of less than 90 per cent. Cocoa-butter has been the centre of some controversy in this connexion, figures of below 90 per cent and above 95 per cent having been reported. Finally, there are certain types of hardened oils (not encountered in Britain) with low digestibilities.

Passing on to the other aspects of nutritive value, Dr. Wilkinson said that while the fats under discussion are, on the whole, free of vitamin-A precursors, they are often rich in vitamin E. What are termed 'essential fatty acids' (linoleic, arachidonic and possibly linolenic acids) are also abundant, although a full account of these factors and of vitamin E in edible oils is not yet available. Palm oil is in a class by itself, and in certain parts of the world it supplies almost the only source of vitamin-A precursors for humans.

Margarine is, of course, a special case so far as vitamins are concerned, because manufacturers in Britain are bound by law to add 550 I.U. of vitamin A, and 90 I.U. of vitamin D, per ounce.

The seed-like structures known as nuts, began Dr. R. Melville, speaking on their nutritive value, are in general highly nourishing, although detailed analyses are still lacking in many cases. Only some of the better known kinds can be dealt with here.

Most nuts are principally valuable as sources of oil and protein, but some have starch as their main food reserve. A well-known example is the sweet chestnut, containing 75 per cent starch (all analytical data on nuts are based on dry weight); others are the acorns, the water chestnut, certain water-lily seeds (including those of the sacred lotus of India and the giant Amazon water-lily), the once-popular 'tiger nut' (swellings on the rhizomes of a pan-tropical water sedge), the seeds of certain pines, and the kernels of the maidenhair tree (*Ginkgo*). Two leguminous seeds, the Yeheb nut and the Bambara ground-nut, also fall into this class.

'Oily' nuts form a larger and more important group. Prominent members are the Juglandaceæ such as walnuts, pecans, hickory and others, containing 59–74 per cent fat, and in one instance, the butter-nut, as much as 29 per cent protein. The Rosaceæ (almond, peach, plum, etc.) all contain more than 40 per cent fat and 22–33 per cent protein. Into the same analytical class come beech nuts (47), Barcelona nuts (67), cashew nuts (47), pistacio nuts (56), many pine nuts (48–79), the Pili nuts (75), Brazil nuts (68), pea-nuts (47), coco-nuts (65) and palm nuts (53)—the bracketed figures give percentage fat. Many of these are also rich in protein—the nuts of the stone pine and pea-nuts containing more than 30 per cent. A few of the Cucurbitaceæ yield edible seeds that may be grouped with the foregoing examples; for example, marrow and melon seeds, containing between 30 and 50 per cent fat, are regularly eaten in China, Africa and elsewhere.

As will be seen from the data, many nuts make an approach to a well-balanced ration so far as protein, fat and carbohydrate are concerned. But so far as vitamin contents are concerned our knowledge is still incomplete. There is evidence that nuts generally are good sources of vitamin B_1, and probably other members of the B complex. The pecan, pea-nut, and Brazil nut are particularly rich in vitamin B_1, contents of the order of 10 μgm. per gram having been recorded. Carotenoids, precursors of vitamin A, are present in some nuts, particularly high values (10 I.U. per gm.) being noted in some walnuts.

Walnuts are also conspicuous among the several nuts known to contain vitamin C, because it has been discovered that the vitamin-C content of the mature kernel is low, and that of the immature green fruit exceptionally high. The endocarp, which is embryonic shell, is initially rich in vitamin C, but the potency falls as the shell develops, and it is possible that the woody material of the shell is built up from vitamin-C-like units. The nuts are richest just prior to the hardening of the shell; in this condition they are gathered for pickling, although if they are pickled to blackness the vitamin C is destroyed. They should therefore be 'green pickled'. More than 1 per cent of vitamin C by weight has been found in walnuts at the appropriate stage of development.

Drs. A. H. Salway and H. G. Rees introduced their paper on "The Nutritive Value of Meat Extract" by recalling that Liebig's original preparation, first marketed about the middle of the nineteenth century, enjoyed considerable popular, but meagre scientific, esteem as a nutrient. The strictures of the experts were of course based on the current belief that nutritive value could be assessed solely in terms of proteins, fats and carbohydrates. It is noteworthy, however, that Liebig himself emphasized the effects of meat extract in promoting the appetite and stimulating the gastric juices. Both these suggestions have since been experimentally substantiated by, for example, Pavlov and, more recently, Fisher and Appleby (*J. Lab. Clin. Med.*, 26, 823; 1941), while the physiological benefits of appetite-promoters such as meat extract have always been recognized by dietitians.

An early claim made for meat extract was its ability to assist muscular effort and to increase stamina. The military hygienists of last century certainly believed in, and acted upon, this claim. Nevertheless, in the absence of scientific evidence, this aspect of meat extract had many opponents. But here again supporting evidence is now accumulating.

Analytically, meat extract is extremely complex, and our knowledge is still incomplete. But the

available information indicates a variety of nutrients the presence of which goes far to explain many of the early claims. True, the albumoses and allied compounds, constituting about 14 per cent of the material, although supplying first-class protein, are of small quantitative significance in the diet. But the meat bases, creatine, creatinine, carnosine, anserine, purines, glutathiones and others, which together account for nearly 30 per cent of the total, are known to stimulate the flow of gastric secretions, to effect muscle metabolism, and to spare proteins from the task of supplying creatine.

It is, however, the vitamins of the B complex in meat extract that are of especial interest and importance.

VITAMIN-B COMPLEX IN FRESH BEEF AND BEEF EXTRACT (EXPRESSED AS μGM. PER GRAM)

	Beef	Beef extract
Vitamin B_1	0·9–3·0	0–1
Vitamin B_2	1·8–3·5	30–35
Nicotinic acid	24–102	1000–1200
Pyridoxine	0·77–4·0	5
Pantothenic acid	4·9–15	25
Choline	760	?
Biotin	0·02–0·03	?
Folic Acid	1·0	?
Inositol	115	?

It will be seen that the concentration of many, although not all, of these essential nutrients is high. A few grams of meat extract per day will supply no inconsiderable part of the daily requirements of the B complex. For example, a third or more of the nicotinic acid requirement is contained in 3–4 gm. of meat extract. This, coupled with the fact that nicotinic acid is now known to be concerned with stamina and mental alertness, provides a further instance in vindication of early claims. Finally, the close relation between the B vitamins and a healthy blood picture no doubt explains why meat extract has long been regarded as 'good for the blood'.

A short but interesting discussion followed, the most notable part of which centred on the vitamin-C content of walnuts. The chairman, Mr. A. L. Bacharach, asked Dr. Melville whether the vitamin-C content of walnuts increased significantly during germination, and if so, whether the shell, which Dr. Melville had envisaged as built up from vitamin-C-like molecules, might, in its immature stages, be the source of the vitamin C. In reply, Dr. Melville said that no work on germination had yet been carried out, but the suggestion would be borne in mind.

OBITUARIES

Prof. W. B. Cannon, For.Mem.R.S.

By the death on October 2, 1945, of Walter Bradford Cannon, the United States and the world lost one who, for a whole generation, had been recognized as a great leader in his own chosen scientific field of physiology. Cannon was born on October 19, 1871, at Prairie du Chien, Wis., and received his schooling at Milwaukee and St. Paul, Minn. Entering Harvard in 1892, he remained with that University and its Medical School until his retirement in 1942 from the chair of physiology, to which he had been appointed in 1906; so that his association with Harvard, as student, graduate, instructor and professor, extended over just half a century.

One of Cannon's most practically fruitful discoveries, and the one from which he could trace, in logical sequence, the development of his later interest in other fields of research, was made when he was still a young graduate, beginning research in the Department of H. P. Bowditch, through whom Cannon could claim to be a 'scientific grandson' of Carl Ludwig. Röntgen's discovery of X-rays was a novelty, and Cannon was interested in using them to render visible, on a fluorescent screen, the passage of a metal ball down the œsophagus of a goose. The idea of mixing with food an insoluble bismuth salt, opaque to X-rays, presented itself to Cannon. With this technique he was able to follow the progress of a meal and its products through the alimentary canal of the normal cat; and thus he not only provided invaluable data for the normal physiology of digestion and absorption, but also furnished to medicine and surgery the principle of one of the most powerful items of modern diagnostic equipment.

In these studies on the visceral movements of a normal, un-narcotized cat, Cannon was early struck by the effects on them, and particularly the immediately depressant, inhibitory effect, of emotional excitement—reactions to sudden noises, or to any cause of fright or anger. These observations, in connexion with evidence then coming from other research centres, led Cannon to enter upon a long and fruitful series of researches on the sympathetic nerves and the control by them of the output of adrenaline from the suprarenal medulla, and on the physiological significance of a sudden output of adrenaline into the circulation, as providing favourable physiological conditions for effective flight or combat. The general outcome of this series was summarized by Cannon, for a circle wider than that of the specialists, in a book, now well known, on "Bodily Changes in Pain, Hunger, Fear and Rage".

Through these studies of the physiological concomitants of emotional reactions, Cannon became interested, as Claude Bernard had been before him, in the accuracy with which the mechanisms of adjustment at the disposal of the living body keep such physiological factors as the content of sugar and the alkalinity of the blood at constant average levels, restoring them rapidly thereto after functional fluctuations. Out of such further studies grew another book, of even wider appeal and more broadly philosophical outlook, entitled "The Wisdom of the Body".

In May 1917 Cannon was a member of the Harvard Hospital Unit which arrived, in advance of the American Army, to play its part in the War in France. After working at a casualty clearing station at Bethune, and gaining direct experience of the physiological factors involved in wound shock, he came to England in November of that year, and engaged, in collaboration with the late Sir William Bayliss, in laboratory experiments arising from his observations in the field. Out of this collaborative experience, together with the exchanges and discussions across the table of a Committee on Wound-Shock then sitting in London, came another book by Cannon. Whatever may be the permanence of results thus snatched to meet war's urgent demands, the experience gained, as Cannon himself was later to claim, helped to re-open an attack on such problems when a second world war made its new demand.

Through his studies on sympathetic and adrenal adjustments of bodily function, Cannon was led to his last main series of researches, dealing with the transmission of nervous effects by chemical agents. Observations of the transmission by the blood, to a

denervated heart, of effects produced by stimulation of distant sympathetic nerves, would seem to have led him to the verge of a discovery which O. Loewi was to make, just at this juncture, by a simpler and direct method. In Cannon's remaining active years he was largely concerned with evidence as to the nature of the sympathetic transmitter 'sympathin', which he believed to be not identical with adrenaline.

No mere account of Cannon's varied and uninterrupted contribution to the growth of physiological knowledge, over all these years, can give any adequate idea of the man, or of his stimulating influence on scientific research in his own country and widely beyond it. His character was drawn on large and simple lines; he was capable of deep and loyal friendships, and readily moved to sympathy and indignation by suffering and injustice. He was a man of sensitive conscience, full of the traditions and the ideals of his native land. He has himself attributed high importance to physical health as a factor of success in an investigator; and in his youth he must have had great strength and endurance. From middle life onwards, however, his health was marred by various allergies, and eventually by a slowly malignant condition, which he suspected to be an after-result of his early experiments with X-rays, in the days before the potential dangers of these were known. His work, however, seemed to be little affected by conditions which must greatly have interfered with his bodily ease and broken his rest.

Cannon was early married to Cornelia James, who had been his schoolfellow. Apart from her own literary activities and social work, Mrs. Cannon shared intimately in her husband's interests, and their household, with a son and four daughters, was radiant with affection and quiet happiness. Cannon's last book, "The Way of an Investigator", is a delightfully discursive talk on the life of research and on the genesis of scientific discovery. It has an autobiographical basis, and an intimate and ingenuous quality which allows a friend almost to hear the tone of Cannon's voice as he reads.

H. H. D.

Mr. J. L. Baird

John Lodie Baird, a pioneer of television, died on June 14, at the age of fifty-eight, after an illness which began in February, up to which time he had been actively engaged in research in various problems in television in the laboratories of his own company.

Baird was the son of a Scottish minister and received his scientific education at the Royal Technical College, Glasgow, where he won an associate scholarship in electrical engineering. Experimental research had always been his hobby, and in the early days of his training he devised an improved pattern of selenium cell, which led him to develop a crude form of television.

When Baird was compelled by ill-health to abandon an active business career, he devoted himself exclusively to a study of the problem of television. He became a pioneer in this field in the early days of sound broadcasting, and was undoubtedly responsible for initiating public interest in this art.

The basic problem of television, as it was correctly appreciated by Baird, consists in the provision of means for scanning an image by subdividing it into tiny elements, transforming the resulting light variations into electrical impulses for transmission by line or radio to the receiver, where the impulses are reconverted back into light for the reconstruction of the picture. Some means for synchronizing the transmitter and receiver must also be provided. For the scanning process, Baird first used a revolving disk carrying a series of suitably placed lenses, and a synchronously driven disk at the receiving end. Very intense illumination was required on the subject to be televized, while the variation in the illumination obtained from a neon lamp was used to reproduce the picture at the receiving end. Working on these lines, Baird gave a demonstration of television on January 27, 1926; this was claimed to be the first demonstration of true television ever witnessed. The original apparatus was afterwards exhibited in the Science Museum at South Kensington.

In the following years, many details of the system were improved and are described in a series of patent specifications. These covered such items as the means of illumination of the subject and even of the use of infra-red radiation to reduce the glare, which the subject found to be unpleasant; accurate methods of synchronizing transmitter and receiver; and an increase in the rapidity of scanning with a corresponding improvement in the definition of the reproduced pictures. Baird's demonstrations of the possibilities of television by radio led to the successful transmission of television across the Atlantic in February 1928, followed a few weeks later by experiments on board s.s. *Berengaria* while the receiving equipment was being brought back from New York.

The first step towards the inauguration of a television service in Great Britain was taken in 1929, when the B.B.C. decided to give Messrs. Baird Television, Ltd., facilities for experimental transmissions through the medium-wave London station. These transmissions, which were afterwards referred to as 'low-definition', employed 30 scanning lines and 12½ pictures per second, the programmes originating in the Baird studios in Long Acre, London. After about a year, these 30-line transmissions were considered to be of sufficient technical interest for the B.B.C. to equip a studio in Broadcasting House with Baird apparatus; and this was put into use in 1932. At this time the development of improved standards of definition was progressing rapidly, and several organisations were experimenting with systems using 120 lines.

In May 1934, the Postmaster-General appointed a committee to report on the relative merits of the several systems of 'high-definition' television, and to consider the conditions under which a public service might be provided using ultra-short waves to accommodate the large band-width necessary for the transmission of such systems. Among the Committee's recommendations was one to the effect that the first station should be in London, and that the two selected systems, Baird and Marconi–E.M.I., should each supply their own apparatus for alternative operation; the cost being borne by the revenue from the existing licence fee. Accordingly, towards the end of 1936, a public service was opened from Alexandra Palace, the two systems of transmission being used in alternate weeks. The Baird system provided 240 lines, 25 pictures per second with sequential scanning; whereas the Marconi–E.M.I. system used 405 lines, and 25 pictures per second with interlaced scanning. After a few months' experience, the Television Advisory Committee recommended that the experimental period should be terminated, and that the standards to be adopted for the London station should be those provided by

the Marconi–E.M.I. system, which is in use in the recently re-opened service from Alexandra Palace.

During all these years and until a few months before he died, Baird continued to work steadily towards the improvement of the scope and possibilities of television and its presentation. The system which bears his name had early taken advantage of the cathode ray tube for reception of the transmitted picture; and in December 1937 he demonstrated in London the optical projection of television pictures on to a cinema screen. The possibilities of introducing colour and stereoscopic effects had for many years also aroused his interest, and in 1944 he gave a demonstration of his recent achievements in the reception of television in colour by a method which avoided the need for revolving disks and lenses.

Altogether Baird played a notable part in stimulating the development of many aspects of television technique, and undoubtedly contributed materially towards the success attained by radio engineers and physicists, resulting in Britain being in the forefront of the world in this fascinating application of electromagnetic waves. R. L. Smith-Rose

Prof. Amadeus W. Grabau

Amadeus W. Grabau was born of German stock at Cedarburgh, Wisconsin, on January 9, 1870, his father and paternal grandfather being Lutheran Church pastors. His grandparents had left Germany in the middle of last century to seek refuge in the United States from persecution for refusal to conform to the practices of the reformed Lutheran Church. Perhaps it was this ancestry which bred in Grabau that stubbornness and refusal to accept current geological dogma without challenge which characterized his career. His radical opinions, expressed with a forthrightness not always to the liking of more conservative minds, touched not only American and Asian geology, but also impinged forcibly on the fundamentals of world geology.

At the age of fifteen, Grabau was apprenticed to a bookbinder in Buffalo, N.Y., but he continued his education at evening classes, discovering the delights of botany and geology. His ability in a correspondence course in mineralogy led Prof. W. O. Crosby, of the Massachusetts Institute of Technology, to offer him in 1890 a post at the Boston Society of Natural History and a special studentship at the Institute. The young man now came into contact with a brilliant gathering of teachers and he responded readily to their influence. His interest in physiography was sharpened, but to it was added a lively knowledge of marine bionomics and, through Alpheus Hyatt and R. T. Jackson, of palæontology. He graduated in 1896, and entered Harvard University in 1897, where he took his master's (1898) and doctor's (1900) degrees. By way of Tuft's College, the Rensselaer Polytechnic Institute and the Geological Survey of Michigan, Grabau passed to a lectureship in palæontology at Columbia University in 1901, becoming full professor in 1905.

Grabau had already published a number of studies on Pleistocene geology, such as "The Pre-Glacial Channel of the Genesee River" (his first paper) and on glacial phenomena of Cape Cod and of Glacial Lake Bouvé. But the richly fossiliferous Lower Palæozoic and Devonian rocks of New York State were an equal attraction, and he published papers on their faunas. In addition, he speculated (sometimes from unsound premises, as with the Fusidæ) on the phylogeny and bionomics of the fossil groups—Devonian fishes, Palæozoic corals and coral reefs, graptolites, gastropods, etc., all passed beneath his scrutiny. These essays were related to numerous others on the classification, nature and formation of sedimentary rocks and of salt deposits; for example, his book "Geology of the Non-Metallic Mineral Deposits other than Silicates. Vol. I. Principles of Salt Deposition" (1920). Grabau's widely ranging interests in stratigraphy, palæogeography, palæontology and sedimentation were, however, inter-related in his mind, and were synthesized into a whole in his "Principles of Stratigraphy" (1913). He stoutly advocated his views at meetings of the Geological Society of America, where his clashes with E. O. Ulrich and A. E. Foerste, who held other opinions equally strongly, became legendary. But the storms of the meeting-room were always followed by peace-making discussions afterwards.

The War of 1914–18 brought a crisis in Grabau's affairs. In an America where the teaching of German at public schools was banned and where streets and places with German names were re-christened, any defence of German literature, arts and science could not be tolerated. But Grabau commended these contributions to world culture, stubbornly refused to explain his views more fully, and ultimately left Columbia. China seized the opportunity and offered him the post of chief palæontologist to the National Geological Survey of China and professor of palæontology at the National University of Peking, which he accepted in 1920.

Grabau plunged with vigour into his new tasks, and quickly built up a flourishing school at the University of Peking. The mass of palæontological material in the collections of the Survey was a mine he explored eagerly. The faunas of China were revealed, with adequate descriptions and figures, in a flood of monographs and papers by Grabau and by students he had trained. His own palæontological contributions were more particularly on the Palæozoic corals and brachiopods, though they embraced other groups from almost every age, and inevitably included discussions of their bionomics. The implications of this work on Chinese stratigraphy were quickly grasped by Grabau, and within four years of his arrival in that vast country he issued the first volume of his "Stratigraphy of China" (volume 2 came out in 1928), wherein he put forth new hypotheses to solve the difficult questions, while he later published a series of papers on "Problems in Chinese Stratigraphy". His "Permian of Mongolia", volume 4 of "Natural History of Central Asia", was the vehicle for a discussion of the Permian of the world, where his original ideas once more coloured a long-drawn-out debate. He held strong views on the migration of geosynclines, and in a number of papers on the pulsation theory strenuously advocated universal transgression and regression for a given geological period. His "Rhythm of the Ages", published in 1940, is characteristically stimulating and full of ideas.

The Geological Society of China honoured Grabau by founding the Grabau Gold Medal, of which he was the first recipient in 1925, while later it celebrated his sixtieth birthday by dedicating volume 10 of its *Bulletin* to him. Its preface, signed by the eight leading Chinese geologists, is a moving testimony to the regard which he had won in his adopted country by the same inspiring enthusiasm, kindly under-

standing and homely hospitality that are not forgotten by his old American students.

In 1933 Grabau re-visited America and was pleased at his welcome and at renewing personal contact with his old friends and antagonists, Foerste and Ulrich. Though some of the old narrow prejudices persisted even later in some quarters, this visit did much to relieve the mental suffering he had so long endured. By then he was already painfully crippled by rheumatism which progressively worsened. He kept bravely on, however, and it is remarkable that such a mass of research work and of ideas could have been produced by one who suffered so severely. The Japanese invasion of China brought increasing difficulties to Grabau. When the Geological Survey and the National University of Peking moved to Kunming, Yunnan, in 1937, his illness forced him to be left behind; but he struggled on, formulating and publishing his ideas, while his Chinese friends got food and money to him whenever possible. After the Pearl Harbour incident, he was housed by the Japanese in the old British Embassy in Peking, but the lack of food and attention and his utter hatred of the Japanese aggression told heavily on the old man. He was very ill bodily and mentally when he was liberated in September, 1945, and despite the care of the authorities of the Geological Survey, he died on March 20, 1946, after internal hæmorrhage. He was a widower with one daughter.

H. Dighton Thomas

NEWS and VIEWS

Newton Tercentenary Celebrations

The three hundredth anniversary of the birth of Isaac Newton fell on December 25, 1942. At that time an international celebration to mark the occasion was out of the question, but the Royal Society devoted the greater part of its anniversary meeting on November 30 of that year to lectures on Newton and his work. Sir Henry Dale, who was president of the Royal Society at that time, spoke in general terms of the significance of Newton as an outstanding figure in the progress of Western science and philosophy. Lectures were given by Prof. E. N. da C. Andrade, Lord Rayleigh and Sir James Jeans, which we were able to print in *Nature* of December 19, with an article by Prof. S. Brodetsky on Newton as scientist and man. The Physical Society and other learned bodies also had special lectures.

As announced by Sir Robert Robinson in opening the Royal Society Empire Scientific Conference, the Society arranged to hold a celebration of wider scope which began on July 15. Delegates from many foreign academies were present and also representatives attending the recent Empire Scientific Conference. The delegates were welcomed by Sir Robert Robinson, who stated in the course of his address that the Royal Society has recently proposed to the British Government a scheme for an Isaac Newton observatory as a national memorial. The scheme provides for a 100-in. reflector and other modern astronomical equipment. The observatory would be the property of the Government, but it would be available for the use of investigators from other observatories. Among the addresses and gifts presented to the Royal Society on this occasion was a copy of a Russian translation of the "Principia" presented by the delegation from the U.S.S.R.

Other items from the programme of the week's celebrations were lectures by Prof. E. N. da C. Andrade on "Isaac Newton"; by the late Lord Keynes (read by Mr. Geoffrey Keynes) on "Newton, the Man"; by Prof. J. Hadamard on "Newton and the Infinitesimal Calculus"; by Academician S. Vavilov (read on his behalf) on "Newton's Atomism"; by Prof. Niels Bohr on "Newton's Principles and Modern Atomic Mechanics"; by Prof. H. W. Turnbull on "Newton: The Algebraist and Geometer"; by Dr. Walter Adams on "Newton's Contributions to Observational Astronomy"; by Dr. Jerome C. Hunsaker on "Newton and Fluid Mechanics". The King and Queen invited delegates to a garden party, and there were visits to the Covent Garden Opera House for a performance by the Ballet Theatre of New York, to Cambridge and the Royal Mint, and a reception by the Lord Mayor and Corporation of the City of London.

British Commonwealth Scientific Official Conference

Mr. Herbert Morrison, Lord President of the Council, opened the British Commonwealth Scientific Conference on July 9. He said that the Royal Society Conference which had just closed was an admirable preparation for the official Conference, in that it provided many opportunities for both formal and informal discussions. Mr. Morrison suggested that a guiding principle in dealing with any problem before the official Conference should be, first, what it is desired to achieve, and then how the desired results can be best brought about and what additional machinery, if any, is necessary for the purpose. It is possible, he warned, to pay too much attention to organisation. If there is the will to co-operate (and there is abundant evidence that this exists throughout the Commonwealth), then very frequently the means follow naturally. It is important to remember, he said, that throughout the British Commonwealth we shall be faced for some years to come with an acute shortage of scientific man-power; and there is a risk that too elaborate organisation may result in absorbing into the administrative machine many scientifically trained men who are badly needed in research laboratories. Careful distinction must also be made between subjects on which work can be safely left to develop along its own lines in the individual countries of the Commonwealth and Empire, and subjects in which successful collaboration demands closely similar methods being employed by all engaged in the work. In the former case, full collaboration can be achieved by ensuring that individual investigators, wherever they may be working, know what others are doing and are able to meet at intervals for discussion of results. The other type of work requires the adoption of concerted plans of action. Mr. Morrison pledged the Government to give most careful and sympathetic consideration to recommendations made by the Conference; and he declared that the Government is determined that science shall play its proper part in the formation

of policy, and its results applied in improving the standard of life both of the people in Great Britain and of the whole Commonwealth.

Science and Anglo-American Relations

The Messel Memorial Lecture of the Society of Chemical Industry was delivered on July 12 by Dr. W. P. Cohoe, president of the Society during 1943–44, and previously chairman in turn of the Canadian and the American Sections of the Society. Dr. Cohoe took as his subject "Science and Anglo-American Relations". Referring to the co-operation which existed during the War, he said that if Great Britain, Canada and the United States could work together for purposes of destruction, it should equally be possible for them to work together in the cause of world peace. The physical domination which they possess involves the responsibility for moral leadership, and Dr. Cohoe pointed out that we have yet to learn the lesson that in scientific findings there resides a centre or nucleus of preparedness which may be used for the preparation of peace. The scientific leadership and pre-eminence possessed by the English-speaking nations at the present time centre around the release and control of nuclear energy, but without belittling such achievements, Dr. Cohoe insisted that we should not overlook the scientific work which has been done for the preservation of the health of the human race. Furthermore, the benefits mankind has derived from scientific advance depend upon common understanding and co-operation between workers in pure science, in technology and in production.

Dr. Cohoe rests his hopes of permanent co-operation between the members of the Anglo-American family on three factors: friendly intercourse; a recognition of the value and use of the religious motive in human affairs; and a common interest in the affairs of everyday life. The use of the scientific method in matters of religion, he believes, will establish freedom from fear of the unknown, from superstition, from orgiastic emotion characteristic of paganism, and from the inhibitions of man-made dogma. Science, he thinks, will be a major factor in the establishment of an everyday common interest in business. But we must face three other problems in international business relations to which he referred briefly in conclusion: the gradual domination of the technological mind over the accounting habit and attitude, a trend which enhances the importance of the technologist being able to expound his ideas and plans clearly; the problem presented by the value of intellectual property, such as patents; and the probability that America, as a consequence of the exigencies of war finance, will become a capital-exporting country and will seek investment in the United Kingdom.

Prehistoric Archæology at the University of Edinburgh: Mr. Stuart Piggott

Mr. Stuart Piggott, who has been appointed to the chair of prehistoric archæology in the University of Edinburgh in succession to Prof. V. Gordon Childe (see *Nature*, March 9, p. 293), is still appreciably under forty and is a notable instance of a man rising to academic eminence without having graduated at a university at the ordinary time of life. He is a native of Petersfield, Hants, where he studied the local archæology keenly in boyhood; he then began his career as a museum assistant at the Reading Museum, where his work both in the museum and as a field student of the antiquities of the Berkshire Downs attracted the attention of archæologists; and he was appointed to the staff of the Royal Commission on Ancient Monuments in Wales. He specialized in the Neolithic archæology of Britain, and in 1932 published what became the standard monograph on British pottery, in collaboration with Prof. Gordon Childe. He next went to the Morven Institute of Archæological Research operated by Mr. Alexander Keiller, with its headquarters at Avebury; in addition to valuable work with Mr. Keiller, he also published further researches of his own, notably on the Early Bronze Age of Wessex and its relations with Brittany and Europe generally and with Mycenean Greece, for he had by this time travelled in France, Greece and Scandinavia. After his marriage shortly before the War, he and his wife settled at Rockbourne near Salisbury and undertook excavations and surveys of the prehistoric antiquities of Cranborne Chase and other districts.

When war broke out, Piggott at once joined the Royal Artillery; when he obtained his commission he was seconded for duty with the R.A.F. Central Interpretation Unit at Medmenham, as experience in interpreting archæological air photographs qualified him especially for this work. So successful was he that in 1942 he was transferred to India, where a similar interpretation unit was built up for the service of S.E.A.C. He remained in India until nearly the end of the War; and found time in intervals of duty to make an intensive study of the prehistoric archæology of Northern and Central India and the districts of Baluchistan between the Indus valley and the Iran–Iraq areas of ancient civilization. Mr. Piggott is an excellent black and white draughtsman, and illustrates all his own work. He will take to Scotland a wide grasp of prehistoric archæology in general and its place in the realm of humane and of scientific studies, as well as a keen eye for the problems of local field-work and excavation.

Civil Engineering at King's College, London: Prof. C. H. Lobban

Prof. C. H. Lobban, who is retiring, during the present summer, from the chair of civil engineering at King's College, London, took his degree at the University of Glasgow and had practical experience in the Glasgow area; he served as demonstrator for two years at that University, going on from there to a lectureship at the University of Manchester, and later to a professorship at Madras. For four years before the First World War he was in practice in Scotland as a civil engineer, and during the War served in France with the Royal Engineers. After serving as assistant controller of the Disposals Board, he joined King's College, London, in 1920. There he is remembered by many generations of engineering students as a keen and efficient engineering teacher, and, in particular, for the elegant solutions that he developed for problems in the field of structural theory. His research work into structural analysis by the deformeter is widely recognized and he was awarded the D.Sc. of Glasgow in 1925 for a thesis on "Grillage and Reinforced Concrete Foundations". He has also carried out important consultative work. He was responsible for the structural design of various buildings, including Victoria House, Southampton Row, London, W.C.1, the London School of Hygiene and Tropical Medicine, and University College, Nottingham. He served as the first technical

officer of the Steel Structures Research Committee of the Department of Scientific and Industrial Research.

Mr. J. S. L. Gilmour

MR. J. S. L. GILMOUR, who has just been appointed director of the Royal Horticultural Society's gardens at Wisley, has been assistant director at the Royal Botanic Gardens, Kew, since 1931, although during the War he was seconded to the Ministry of Fuel and Power. While at Kew he showed himself to be an able administrator, and his genuine and assiduous interest in the welfare of the student-gardeners will engender a feeling of personal loss beyond the circle of his immediate colleagues. It is a happy augury for the future of horticulture that the directorships of the Royal Gardens, Kew, and the gardens at Wisley should be thus held by men linked by ties of friendship and common interests. Changing economic conditions must inevitably bring about considerable re-orientation of the pursuits and interests of the fellows of the Royal Horticultural Society and thus influence the purpose and policy of their Gardens, so that our good wishes go out to Mr. Gilmour in his difficult but interesting task.

National Union of Teachers: New General Secretary

MR. RONALD GOULD has been appointed general secretary of the National Union of Teachers in succession to Sir Frederick Mander, who is to retire in 1947. Mr. Gould was president of the Union during 1943–44. He is at present headmaster of Welton Council School, Bath, and is a well-known figure in the teaching world. He was educated at Shepton Mallet Grammar School and received his professional training at Westminster College. After leaving college, he was appointed assistant master at Radstock Council School, and while in this area became president of the Radstock Association of the National Union of Teachers, a representative on the County Teachers' Association and Somerset's representative on the Lower Paid Areas' Association Council. He was elected as an executive member of the National Union of Teachers in 1937. He has been a member of the Burnham Committee on Teachers' Salaries since 1938.

Society for the Protection of Science and Learning

IN 1933, when the rise of the Nazi party rendered the position of men of science and other scholars extremely dangerous, the Academic Assistance Council was founded to help the refugees; later its title was changed to the Society for the Protection of Science and Learning. The recently published fifth annual report (issued from Westminster College, Cambridge) surveys the Society's activities for the years 1939–45. These years, being war years, have necessitated the limitation of the survey chiefly to an account of the academic refugees in Great Britain. Of the 2,541 individuals who were registered, only 601 are now in this country. The majority of those who have found employment abroad are in the United States. Some of these are in the special foundations of French and Polish exiled scholars, or on the staff of the School for Social Research in New York. Spanish exiles have found their way to Mexico, and the Central and South American countries have absorbed a large number of the refugees. Others have gone to the British Dominions, some to Turkey, Palestine, Sweden and Switzerland. Of those in Great Britain, about 40 per cent are in universities and parallel institutions. Another group, about 36 per cent, are employed in some of the professions, industry and the Government service. Scholars of Allied nationality have returned or will return to their own countries if they are Dutch, Belgian, French or Scandinavian, but the Poles and some of the Czechs are in a difficult position. So far as numbers are concerned, the Germans and Austrians present special problems. Some with a good war record have been naturalized; these will presumably remain in Britain, but some definitely wish to return, and discussions are now taking place for the return of some of them to the British zone. The report emphasizes that the Society is not a welfare agency in the usual sense, but exists to make the work of refugee scientific workers and other scholars available, by maintaining them while other support is not forthcoming. It is expected that in a few years time the activities of the Society will be considerably curtailed, but in the meantime much work still remains to be done.

Fifty Years of Danish Marine Biology

THE interruption to research caused by the War has been utilized by Dr. Blegvad to produce a lavishly illustrated account, full of interesting personal details, of the first fifty years work of the Danish Biological Station (*Report Danish Biol. Stat.*, 45; 1940, published 1944). In 1899 a moored transport vessel was adapted for use as a laboratory under the direction of C. J. Johannes Petersen. A long series of papers published during thirty years shows how much marine biology owes to his energy, ability and originality. Early famous for his invention, still in use, of a method of marking living fish, his bottom-sampling grab led to a greatly extended knowledge of animal life of the sea-bottom and of the food available for marketable fish such as plaice. The laboratory has always been closely connected with the University of Copenhagen, while under the late A. C. Johansen and the present director there has developed a friendly and valuable collaboration with the fishermen, who have benefited financially from the experiments on transplantation of young plaice from the North Sea to richer feeding-grounds. Housed now in the beautiful Charlottenlund Castle, with a fine modern aquarium close by and a well-equipped research vessel and motor-boat available, the Station is well qualified to play again an active part in solving regional and international problems of aquatic biology.

Nuclear Energy and its Utilization

AN address delivered at Cordoba Observatory, Argentina, by E. Gaviole, president of the Argentine Physical Association, points out that men of science are generally agreed that within five years every major industrial country that wishes will possess atomic bombs, that there is no defence against surprise atomic aggression and in any such warfare both combatants will suffer unparalleled destruction in a few days. Accordingly, the object should be to avoid war; and nations should surrender a part of their sovereignty to achieve security. Commenting that the scientific workers of the southern hemisphere are in a privileged position and unlikely to be a target, Dr. Gaviole suggests that the fact that governments themselves will be exposed to attack

may be a factor in avoiding war, but points out that disarmament, by putting a premium on the power that breaks agreements and arms secretly, is dangerous. He questions the practicability of international organisation in the shape of a police force, partly on the grounds of loyalties, and suggests that any international organisation of scientific workers would be rendered futile by these factors of secrecy and national loyalties. While Dr. Gaviola displays the difficulties of the situation, he appears to lose sight altogether of the favourable factors emphasized by the American report on the international control of atomic energy, and a rather depressing and complacent address demonstrates the need of the moral imperative stressed in the report from the Commission appointed by the British Council of Churches.

Training of Demobilized Electrical Engineers

Among the various questions considered at a recent meeting of the Electrical Engineering Committee of the Technical and Scientific Register were proposals for securing employment for men who joined the technical branches of the Forces immediately on graduation and are now being demobilized. They have not previously had industrial experience, but many have had the advantage of commissioned service in technical corps and have shown qualities of leadership and initiative which should be of great value to industry. Suggestions made by the Committee are likely to lead to experimental schemes of training in industrial concerns with the view of preparing these ex-Service personnel for responsible posts after training. The Committee realizes that adequate pay arrangements will be required in order to make training schemes of this kind economically practicable. The Committee stressed the importance of developing still further the close co-operation which already exists between the Ministry of Labour's Technical and Scientific Register and the Professional Engineers Appointments Bureau, and expressed the hope that industry generally would make use to the fullest possible extent of the facilities offered by the Register. The Committee also considered a detailed report of the work of the Electrical Engineering Section of the Register.

Luccock Medical Research Fellowships

The Luccock Fellowships have been established by King's College, University of Durham, as a result of the bequest of the late Mr. J. W. Luccock, who left his money "to enable research to be made and carried on as to the component parts of the blood of human beings with the view and in the hope that such research investigation and enquiry will be of benefit to the human race and increase the knowledge of the medical and surgical profession as to all matters relating to the blood which may result in the alleviation of human suffering and probably the prolongation of life". Fellows elected will be required to pursue full-time research in the University of Durham in an approved subject in the field of medicine (including dental surgery). Senior fellowships are of the minimum annual value of £600 and are open to any person who by publication or otherwise has proved himself able to carry out original research in the field of medicine (including dental surgery) and are tenable for three years. Junior fellowships are of the minimum annual value of £300 and are open to any person holding medical, dental or scientific qualifications, and are tenable for one year. Supplementary grants in aid of the expenses of the research may be sanctioned by the Council of the College, and any apparatus purchased by these means will remain the property of the College.

Spitfire Mitchell Memorial Scholarships

As a memorial to the work of Mr. R. J. Mitchell, designer of the Spitfire, two Spitfire Mitchell Scholarships have been founded to train students in aircraft design and engineering. These Scholarships will be of the value of £60 a year for three years and will be tenable at University College, Southampton. Applications should be made to the Registrar, University College, Southampton, not later than August 12, and should be accompanied by a statement of the candidate's education and experience, and a recommendation from his employer or headmaster, together with the candidate's own age, which must be more than seventeen. The awards are in the hands of the Royal Aeronautical Society, the Society of British Aircraft Constructors, Messrs. Vickers-Armstrongs, Ltd., and the Committee of the Spitfire Mitchell Memorial Fund.

Announcements

Prof. Lise Meitner will deliver a public lecture on "Atomic Energy" at Chatham House, St. James's Square, S.W.1, on July 30 at 8 p.m. Admission is free by ticket obtainable from the British Federation of University Women Ltd., 17a Kings Road, London, S.W.3.

Mr. Horace Cole has been appointed lecturer in the chemistry of glass in the University of Sheffield. The following resignations have been announced: Dr. Andrew Wilson, lecturer in pharmacology and therapeutics; Dr. J. Dick, lecturer in mechanical engineering; Dr. J. H. Hale, assistant bacteriologist and demonstrator.

Mr. Cyril Bibby, at present education officer to the Central Council for Health Education, is resigning that post on his appointment as senior lecturer at the College of St. Mark and St. John, Chelsea, London.

As one method of meeting the demand for chemical engineers which modern industrial development is creating and increasing, the Ministry of Education is arranging for full-time intensive training courses in a number of technical colleges (see *Nature*, July 6, p. 20). The courses will last for approximately twelve months, and will be recognized by and operated in co-operation with the Institution of Chemical Engineers. Applications for further information (Leaflet P.L. 216) should be addressed to the Ministry of Labour and National Service, Technical and Scientific Register, York House, Kingsway, London, W.C.2.

In furtherance of its policy of promoting the study of textile technology, the Textile Institute is now offering two scholarships for students, each of three years tenure and of total value £750. The scholarships are offered under the terms of a grant from the Cotton Trade War Memorial Fund, and young craftsmen engaged in the cotton spinning or weaving industry are eligible. Forms of application, conditions and other information are available from the General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester 3. Applications must be made by August 3.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Medical and Other Patents for the Use of Mankind

BEFORE the War my laboratory was supported by the Josiah Macy Jr. Foundation, New York, receiving 3,000 dollars a year. This help enabled me to work without limitation and publish without restriction. During the War, this help ceased and forced me to seek the help of industry. I worked out a method for the preparation of a substance of high biological importance and therapeutic value, a substance which has found no application yet for lack of a suitable method of preparation. As a recompense for the help obtained, I had to offer this method to industry and keep it secret. The result is that for the sake of 10,000 dollars a substance is inaccessible which could relieve much human suffering. In the present financial conditions of my country, the State is unable to give necessary support for research; and I, having greatly extended my laboratory, am compelled to seek further collaboration with industry. Possibly my work will lead shortly to the discovery of new, highly important substances, and I shall be unable to talk about them freely. The other laboratories and research workers of my country are in a similar condition and the free, generous, international spirit of science is endangered. Maybe my country, being small and poor, does not matter much; but such trends spread easily and should be suppressed at their roots.

I wish to submit this problem to readers of *Nature*. I wonder whether the United Nations Educational, Scientific and Cultural Organisation could do something in this matter, perhaps suggesting to chemical industries the creation of an international fund for the support of research and for purchasing patents for the common use of mankind or, at least, for the use of the contributors, enabling at the same time researchers to work and publish freely. I expect most research workers would prefer to offer their work and results to such a body, which may even solve the old problem of how scientific men can be protected from exploitation and enjoy the fruits of their own work without disadvantage to the human community.

A. SZENT-GYÖRGYI

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April 7.

Reactions of Organic Halides in Solution

DR. A. G. EVANS has recently discussed those bimolecular and unimolecular substitutions in which a nucleophilic reagent displaces halogen as halide ion from an alkyl halide[1].

With reference to the bimolecular reactions (S_N2), he ascribes to us the view that the diminution of rate along the series Me, Et, *i*-Pr, *t*-Bu is entirely due to the polar effect of the alkyl group. This is a mistaken presentation of our ideas. For, in the first place, we regard the polar and steric effects as both contributing to the structural influence on rate: we stated this qualitatively in 1935[2], and have more recently indicated means of assessing quantitatively the separate effects[3]; furthermore, in 1937[4] we emphasized the special importance of steric hindrance (which has its physical basis in the exclusion principle) in relation to the spatial orientation of bimolecular substitution, contrary to an earlier idea[5] that polarity was determinative in this connexion. The second important point is that, as we have repeatedly insisted, the polar effect in bimolecular reactions is itself ambiguous[6]: it includes a polarizability effect, and therefore depends (for substitutions) not only on the compound substituted, but also on the substituting agent and the solvent. For example, in substitutions of alkyl halides in polar solvents by simple anionic reagents, such as halide or alkoxide ions, the polar effect may be expected to lead to rate differences in the direction illustrated; but this inference from simple electrostatic considerations does not embrace corresponding substitutions by such neutral reagents as pyridine. Our picture of the situation has been explained at length in our papers, and is not susceptible of the type of simplification with which Evans has tried to represent it.

Evans himself takes the extreme view that the polar effect envisaged by us is completely absent from the bimolecular substitutions, though steric hindrance remains important[7]. That the polar effect is not absent in general from bimolecular nucleophilic substitutions is consistent with the result of exchanging the electron-releasing methyl substituents for electron-attracting groups: here, in the case of substitution by anionic reagents, we find that the effect of the substituent, in spite of steric hindrance, is often accelerative. We pointed this out in 1935, using the illustrations then available: several new examples have since been recorded. For an assessment of the relative importance of polar and steric effects in cases in which both reduce reaction-rate, we again refer to our general discussion[3]. We agree that steric hindrance is present in the bimolecular substitutions of α-methylallyl halides: Catchpole had pointed this out[8], and the case is included by implication in our general consideration of steric hindrance by alkyl groups. The conclusion does not, however, follow logically from Evans's argument, which, by carrying over a rate comparison of two compounds from one reaction mechanism to another, ignores the duplex nature of polarity and the dependence of polarizability effects on mechanism[6].

Turning to the unimolecular substitutions (S_N1), the rates of which are controlled by the rates of ionization of the alkyl halides, Evans concludes that the increase of rate along the alkyl series Me, Et, *i*-Pr, *t*-Bu is "due to" the decrease of ionization potential of the alkyl radical. We agree that the two phenomena are related, but would prefer to express the relationship by saying that the increase of ionization-rate and the decrease of ionization potential (in other words, the ease with which an alkyl cation separates, on one hand, from an anion, and on the other, from an electron) are analogous manifestations of the same structural causes.

E. D. HUGHES
C. K. INGOLD

Sir William Ramsay and Ralph Forster Laboratories,
University College, London.
June 14.

[1] Evans, A. G., *Nature*, **157**, 438 (1946).
[2] Hughes and Ingold, *J. Chem. Soc.*, 244 (1935).
[3] Hughes, *Trans. Farad. Soc.*, **37**, 603 (1941). Dostrovsky and Hughes, *J. Chem. Soc.*, 157 *et seq.* (1946). Dostrovsky, Hughes and Ingold, *J. Chem. Soc.*, 173 (1946).
[4] Cowdrey, Hughes, Ingold, Masterman and Scott, *J. Chem. Soc.*, 1256 (1937).
[5] Meer and Polanyi, *Z. phys. Chem.*, B, **19**, 164 (1932).
[6] Ingold, *Chem. Rev.*, **15**, 225 (1934). Hughes, Ingold and Shapiro, *J. Chem. Soc.*, 225 (1936). Bateman, Cooper, Hughes and Ingold, *J. Chem. Soc.*, 925 (1940). Hughes, Ingold and Taher, *J. Chem. Soc.*, 949 (1940).
[7] Evans, A. G., and Polanyi, *Nature*, **149**, 608, 665 (1942).
[8] Catchpole, A. G., Thesis, London (1942).

Friedel–Crafts Catalysts and Polymerization

IN an earlier communication[1], evidence was given upon which the following conclusion was based. In the dimerization of di-isobutene and the polymerization of isobutene, it is essential that a trace of some third component, *X*, shall be present in addition to the monomer and the Friedel–Crafts catalyst, in order that the reaction shall proceed at an appreciable rate. It was suggested then that this third component was probably water. We have continued this line of investigation by studying the boron trifluoride-catalysed polymerization of isobutene in the gas phase using high-vacuum technique. The polymerization reaction was followed by mixing the boron trifluoride and the isobutene in the gas phase and measuring the fall in pressure with time. We may summarize the results as follows:

(*a*) The unpurified isobutene, taken straight from the cylinder, reacts rapidly when its pressure is greater than a certain value (Curve *A*).

(*b*) Isobutene, purified by many distillations from − 80° C. to liquid air *in vacuo*, reacts very slowly under conditions which are otherwise identical with those for the experiments described in (*a*) (Curve *B*).

(*c*) The purified isobutene reacts rapidly if mixed with vapour of the residue from the distillation described in (*b*) (Curve *C*).

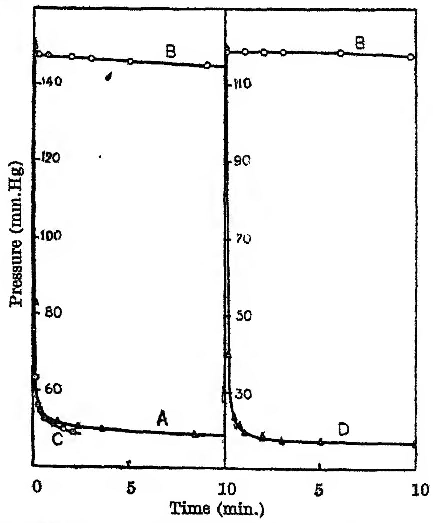
(*d*) This residue was identified as water by measurements of vapour pressure and freezing point.

(*e*) Purified isobutene reacts rapidly if previously mixed with water vapour. So little as 10^{-1} mm. of water vapour is sufficient to give the rapid reaction (Curve *D*).

(*f*) When water is present with the isobutene in the gas phase, part of the boron trifluoride which is introduced into the mixture is removed by combination with the water. The boron trifluoride and water combine in practically equal molar quantities.

(*g*) When water had been added to purified isobutene to cause the rapid reaction in one experiment, the addition of boron trifluoride to the purified isobutene alone in the subsequent experiment was sometimes found to lead to rapid reaction. If the reaction vessel was pumped out for about half an hour between the two experiments, however, the purified isobutene used alone in the second experiment did not give the rapid reaction on addition of boron trifluoride.

We conclude from these experiments that for isobutene to be rapidly polymerized in the gas phase, the presence of both BF_3X and excess boron trifluoride are necessary. In the experiments described in this communication, the third component, *X*, is water.



A, UNPURIFIED ISOBUTENE; *B*, DISTILLED ISOBUTENE; *C*, DISTILLED ISOBUTENE PLUS 1% RESIDUE VAPOUR; *D*, DISTILLED ISOBUTENE PLUS 0·1% WATER VAPOUR

Note added in proof. If a mixture of purified isobutene and boron trifluoride, undergoing the very slow reaction in the gas phase at room temperature, is condensed in liquid air, it is found on warming up that all the isobutene has polymerized.

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G. W. MEADOWS
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June 19.

[1] Evans, A. G., Holden, Plesch, Polanyi, Skinner and Weinberger, *Nature*, 157, 102 (1946).

Composition of Cupric Ammino Nitrates

IN a recent publication[1] from this laboratory, we have described our results on the study of the composition of cupric ammino sulphates by the new electrical conductivity method[2] of Dey and Bhattacharya. In other communications we have described the isolation of cupric pentammino sulphate by alcoholic precipitation from ammoniacal solutions of cupric sulphate.

The new electrical conductivity method has now been applied to the study of the compositions of the cupric ammino nitrates and I shall here briefly report the results obtained. The method consists in the determination of electrical conductivities of a solution of cupric nitrate, of solutions of ammonium hydroxide of various concentrations and also of mixtures of cupric nitrate with different concentrations of ammonia. The conductivity of the mixture was observed to be higher than that of either constituent, and even greater than the sum of the conductivities of the constituents of the mixture. A graph was plotted with composition as the abscissæ and the percentage increase in conductivity as the ordinates. The curve gave several breaks corresponding to 3, 4, 5 and 6 molecules of NH_3 for a molecule of $Cu(NO_3)_2$, thus leading to the inference of the existence of tri-, tetra-, penta- and hex-ammino compounds of cupric nitrate.

The light absorption of mixtures of cupric nitrate with varying concentrations of ammonia were studied by a Nutting's spectrophotometer, and we obtained shifts in the regions of maximum absorption corresponding to mixtures of the compositions $Cu(NO_3)_2.4NH_3$, $Cu(NO_3)_2.5NH_3$ and $Cu(NO_3)_2.6NH_3$. We could not study the mixture with lower dilutions of ammonia as the solution becomes opaque due to hydrolysis.

Thus these results confirm the existence of the well-known tetra- and penta-ammino compounds of cupric nitrate. Horn[4] isolated a compound $4Cu(NO_3)_2.23NH_3$, which has been called the hexammino compound by some workers. It seems that Horn obtained the hexammino compound, but probably due to its unstability he could not determine the correct composition. My results also favour the existence of the hexammino compound. Further, the existence of the new triammino compound is undoubted, as shown by my electrical conductivity experiments.

I am indebted to Dr. A. K. Bhattacharya for his kind interest in this investigation.

ARUN K. DEY

Department of Chemistry,
University of Allahabad.
May 20.

[1] Dey and Bhattacharya, *Curr. Sci.*, 14, 69 (1945).
[2] Cf. Dey, *Curr. Sci.*, 15, 24 (1946).
[3] Dey and Bhattacharya, *Curr. Sci.*, 14, 201 (1945); *Proc. Ind. Acad. Sci.*, 23 A, in the press.
[4] Horn, *Amer. Chem. J.*, 37, 620 (1907); 39, 216 (1908).

Thorium Borate Sol and Gel

BERZELIUS[1] reported that boric acid precipitates white flocculent thorium borate when added to a solution of a salt of that element; the precipitate is insoluble in an excess of boric acid. Karl[2] discussed the composition of the amorphous white precipitate obtained by treating an aqueous solution of thorium nitrate with a hot solution of borax and showed that the composition corresponded with thorium orthoborate, $Th_3(BO_3)_4$. Guertler[3] could not prepare thorium borate by fusing thoria with boric oxide on account of the very sparing solubility of the thoria. A search of the literature revealed that no work is on record on the formation of the hydrosol and the hydrogel of thorium borate. An attempt has now been successfully made in this laboratory to prepare thorium borate hydrosol and hydrogel.

When a hot concentrated solution of borax is gradually added to thorium nitrate solution, a white precipitate of thorium borate is obtained which dissolves on vigorous shaking in presence of excess of thorium nitrate. In this way a considerable amount of thorium borate can be made to disperse in thorium nitrate. If this mixture be now kept in a parchment bag and dialysed until free from electrolytes, a clear colourless sol of thorium borate is obtained. The sol can be shown by electrophoresis to be positively charged.

A sol was prepared by allowing a hot 20 per cent solution of borax to run slowly into 75 c.c. of 10 per cent thorium nitrate solution until the precipitate of thorium borate scarcely dissolved in thorium nitrate on vigorous shaking. The mixture was dialysed at room temperature (30° C.) for eight days. The analysis of the coagulum of the sol obtained by the cataphoretic method indicated that the empirical formula of the sol was $4ThO_2.Th_3(BO_3)_4$.

The sol could be easily coagulated with electrolytes; and when N potassium chloride and $N/5$ potassium sulphate were used as coagulators, the sol formed beautiful transparent jellies. The influence of the variation of the concentration of the coagulating electrolytes on the time of setting of the gel is shown in the table:

Amount of sol taken = 2 c.c.; total volume = 3 c.c.

Amount of $N/5$ K_2SO_4 (c.c.)	Time of setting (min.)	Amount of N KCl (c.c.)	Time of setting (min.)
0·28	2	1·00	4
0·26	4	0·80	8
0·24	7	0·60	12
0·22	10	0·40	20
0·20	15	0·20	52

These jellies are quite stable and can usually be kept for days without appreciable change. On vigorous shaking they assume a liquid form, and the viscous liquid so obtained again sets to a jelly on standing; this process can be repeated several times. These jellies are therefore thixotropic in nature.

My thanks are due to Dr. Satya Prakash for valuable suggestions and his interest in this investigation.

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Differentiation between Glucose, Galactose and Mannose by a Colour Reaction

THREE naturally occurring aldohexoses—glucose, mannose and galactose—can readily be differentiated by the following method. Add 2 mgm. of the unknown sugar material to a solution of pyrocatechol at a concentration of 0·2 per cent in 85 per cent phosphoric acid syrup. Heat for 15 min. in a boiling water bath, shaking vigorously at the end of the first minute of heating to effect solution of the sugar. In these conditions, glucose produces a lilac colour, mannose produces a brown colour and galactose produces a red colour intermediate in quality between the colours afforded by glucose and mannose. The test is applicable equally to free and polymerized aldohexose. Amino-acids (apart from tryptophane) and gelatine do not produce colour in these conditions, and do not interfere even in large amount with this test.

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Influence of Gonadal Hormones on the Serum Lipochrome and Riboflavin of the Domestic Fowl

TRICHLORACETIC acid filtrates of serum were prepared during an investigation of the effects of gonadal hormones on the mineral metabolism of the immature pullet. Such preliminary removal of protein is essential in determining serum calcium where much vitellin or phospholipid is present, as is the case in laying birds or birds treated with œstrogen. It was noticed that filtrates from the sera of the pullets (fourteen weeks old) were tinted a greenish-yellow colour in the case of those birds receiving heavier doses of œstrogen, while the sera of birds not receiving œstrogen were colourless. A direct dietary influence was excluded because the birds, which were of the same strain and hatching, had been reared together under the same conditions and had, for three weeks before the observations, received the same amounts daily of the same diet.

The fact that the trichloracetic acid precipitate removes lipid material as well as protein prompted an examination for the presence

Pullet No.	Total dose œstradiol dipropionate (Ciba) (mgm.)*	Total dose testosterone propionate (Ciba) (mgm.)*	Serum calcium (mgm./100 ml.)	Plasma lipochrome, (Lovibond yellow units)**	Serum riboflavin (p.p.m.)
25	0	0	12·6	0·6	trace ?
26	6	0	17·4	0·8	0·05
27	12	0	38·3	1·2	0·27
28	24	0	97	1·6	1·22
29	0	8·25	12·4	0·8	trace ?
30	6	8·25	28·6	0·8	0·09
31	12	8·25	76	1·4	0·39
32	24	8·25	100	1·7	1·25

* Divided into six doses administered intramuscularly on alternate days.
** Alcohol-ether extract (10 ml.) of 0·5 ml. plasma examined in 2 cm. cell.

of riboflavin as an acid-soluble coloured substance, which might conceivably be mobilized for egg production.

After adjusting the filtrate to pH 6·0, the solution displayed a fluorescence indistinguishable from that of standard riboflavin solutions. This fluorescence was destroyed by sodium hydrosulphite and it was, therefore, possible to make preliminary fluorimetric estimations of riboflavin. The relevant results are summarized in the accompanying table.

These observations suggest that the relations of gonadal hormone activity to the mobilization, and also possibly the metabolism, of certain vitamins in the fowl may offer a fruitful field for investigation There is already evidence that variations in the vitamin A content of the human ovary are related to the production or storage of the sex hormones[1]. The mobilization of lipochrome (presumably carotenoids for the yolk) in the serum of the œstrogenized or actively laying fowl must also be familiar to all who have prepared phospholipid extracts from the sera of such birds. Again, the yellow colour of the distinctly flocky trichloracetic acid protein precipitate from such sera and the removal of this colour by alcohol-ether extraction gives a qualitative impression of the association of serum vitellin with lipochrome. However, to the best of our knowledge, such observations have not before been extended to water-soluble pigments such as riboflavin.

Further experiments are being undertaken to investigate the possible mobilization of other vitamins, particularly vitamin A and aneurin, as well as a further investigation of the effect on serum riboflavin.

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Use of Synthetic Resins in the Estimation of Trace Elements

IF trace elements in plant material are to be estimated polarographically, a digest free from organic substances must first be prepared. Piper[1] has reported that appreciable losses occur during ashing, owing to the volatility of inorganic components and adsorption to the surface of the ashing vessel. Digestion with mineral acids and oxidizing agents on the other hand gives solutions of high total ionic concentration, and the polarograms, as shown by Reed and Cummings[2], are often vague. As in many colorimetric estimations, therefore, it is necessary to isolate elements from the digest before they can be estimated accurately. If several elements can be isolated simultaneously, there is the possibility of estimating them in a single polarogram.

It appears probable that trace elements may be isolated from a plant digest by the use of synthetic resins.

A column of bed volume 1 ml., packed with granules of Amberlite IR100, was washed and classified as recommended by McReady and Hassid[3], and taken through several successive exchange cycles with normal hydrochloric acid and normal ammonium chloride solutions. 2 ml. of a solution containing copper, cadmium, nickel, zinc and manganese salts, each in concentration approximately 4×10^{-4} M, was introduced to the purified column, and the adsorbed cations subsequently eluted with hydrochloric acid.

In the presence of normal ammonium chloride, the cations were not fully retained by the column, but appeared in the first fractions issuing. The excess cations in the original solution themselves displace the trace elements.

In the presence of decinormal salt solutions, however, cations were fully retained.

By varying the nature and concentration of the solution used in eluting the adsorbed cations, it should be possible to isolate them in successive fractions of eluate. For example, decinormal hydrochloric acid displaced only cadmium, whereas normal hydrochloric acid liberated the zinc, manganese, copper and nickel in addition. Although the proportions of the various cations varied in successive fractions of the effluent solution, a full separation was not achieved.

Cations may be separated from interfering anions during the passage through a column. Thus, with decinormal phosphate present in the original solution, the phosphate passed through and was recovered quantitatively, while the trace elements were adsorbed. Elution with hydrochloric acid gave the trace elements free from phosphate ions. This separation may prove useful in the treatment of plant extracts, in which a precipitate containing calcium and magnesium phosphates is formed when the pH is greater than 5. On the surface of this precipitate, trace elements are strongly adsorbed. For this reason it is not possible to use neutral or alkaline supporting electrolytes in the polarographic analysis of plant digests, unless the phosphate is first removed.

In the table, polarographic step heights (all converted to full galvanometer sensitivity) are reported without converting them to concentrations. In the ammoniacal buffer used as supporting electrolyte[4], the step heights are approximately proportional to concentrations within this range.

These high recoveries of trace elements present only in minute quantities suggest that the method may prove useful in analysing samples of plant material as small as 1 gm. with an accuracy better than 10 per cent (the value accepted in spectrographic determinations).

Since plant digests intended for passage through a resin column must have a low total ionic concentration, the normal treatment with involatile sulphuric and perchloric acids is unsuitable. Plant material which has been charred at 250° C. to remove volatile organic substances dissolves in fuming nitric acid, giving a pale yellow solution from which excess acid may be removed by evaporation. It is hoped that such a digest may prove suitable for chromatographic separations.

The isolation of anions by passage through a column of Amberlite IR4 may be somewhat more difficult, since the reaction rates here are smaller. Polarographic estimation of many anions is now possible, and, once these ions have been isolated from interfering substances, the appropriate supporting electrolyte may be selected for each estimation.

Temperature 20° C. $m^{2/3}\tau^{1/6}$ 1·76 mgm.$^{2/3}$sec.$^{-1/2}$

	Cu	Cd	Ni	Zn	Mn	
Total amounts of trace elements introduced in 2 ml. solution	1·26	1 42	1·36	1·22	$1·46 \times 10^{-6}$	gm.-equiv.
Corresponding measured step heights	165	335	306	352	227	mm.
A. Trace elements in *N*/10 amm. phosphate recovered by eluting with normal HCl						
First 10 ml.	120	318	218	316	178	
Second 10 ml.	35	4	73	33	28	
Third 10 ml.	0	0	5	6	0	
Total	155	322	296	355	198	
B. *N*/10 amm. phosphate alone (Blank for total reagents) 30 ml. *N*.HCl	12	0	4	28	0	
Total % recovery	87	96	95	93	87	
(Recovery in first 10 ml. eluate	70	95	71	87	78)	

This work was carried out at East Malling Research Station as part of the mineral deficiencies programme financed by the Agricultural Research Council. I wish to thank Dr. G. A. Gilbert for suggesting the use of synthetic resins, and Charles Lennig and Co., Ltd., for arranging a supply of the Amberlite resins through their principals, the Resinous Products and Chemical Company.

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A New Virus Disease of Tomatoes

IN the 1944 growing season a number of tomato plants grown as an outdoor crop under commercial conditions were noted as being infected with a virus disease. Subsequent work on this disease has revealed that it has been hitherto unrecorded. The purpose of this note is to put on record the disease which has since been found on a number of commercial holdings. Further details will be published shortly, but the effects of the disease appear to warrant this preliminary statement.

Affected plants are noticeably stunted and there is in the early stages marked growth of the axillary shoots giving a 'bushy' appearance to the plant. The growing point of the stem is malformed and may be suppressed by the disease, and this apparently increases the proliferation. At the same time, marked proliferation takes place on the main rachis at the bases of the individual leaflets, after 'stopping' and 'disbudding' in the normal way. Further, the fruits on the upper trusses of infected plants, that is. those which were formed after infection, are almost without exception entirely seedless and are usually very much smaller than normal seeded fruits. The complete suppression of seed formation is of special interest as regards the effect of virus diseases on megaspore and microspore formation[1].

The disease is sap-transmissible and readily induces systemic infection in *Nicotiana tabacum* and in *N. glutinosa*. Symptoms appear two or three weeks after inoculation in both cases. In *N. tabacum* a green-yellow mosaic is produced with some ring spotting; in *N. glutinosa* necrosis and leaf distortion are accompanied by a dark green 'blistering' effect. There are no local lesions on the inoculated leaves.

Sap transmission of the disease into tomato was found to occur less readily than into *N. tabacum* and *N. glutinosa*, and repeated sap inoculations into a range of other solanaceous plants were unsuccessful.

The virus is markedly non-persistent in extracted sap, remaining infective for only one or two days at room temperature. It is inactivated by heating for ten minutes at 50° C.

The distribution of diseased plants in the bed where the disease was first noted indicated that a block of chrysanthemums growing near by might well be the source of infection, and this has since been confirmed. A virus identical in behaviour with that obtained from the diseased tomato plants has been obtained from the chrysanthemums. The symptoms in chrysanthemum are not well developed, the plants being somewhat stunted, with some chlorosis in the leaves.

Observations on the disease in field crops of tomatoes under both experimental and commercial conditions have shown that the spread is rapid and that it can cause serious reduction in the yield of fruit—the fruit on infected plants being so undersized as to be valueless. Field experiments indicate that an aphis is the vector. Mechanical transfer of the virus in 'stopping' and 'tying in' the plants does not appear to be a probable method of transmission.

It is hoped to complete detailed investigations on the spread and effect of the disease and on the nature of the vector in the course of the present growing season.

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Effect of Copper-Enzyme Poisons on Soil Nitrification

THE possible biological importance of an activated copper nitrogen complex has been repeatedly stressed by Baudisch[1]. I have therefore tried the effect of some well-known copper-enzyme poisons on soil nitrification, which is the process whereby ammonium ions are oxidized to nitrite ions and thence to nitrate ions by the microflora in soil. The percolation apparatus used in this work was an improved and simplified version[2] of the one already described[3].

Ten grams of a Kent marsh soil were initially percolated with 100 ml. of $M/200$ ammonium chloride to stimulate nitrifying activity in the soil. When the soil was nitrifying well (as indicated by a rapid rise of nitrate in the percolate) the percolate was discarded and the soil rinsed three times with 50 ml. lots of a $M/250$ solution of one of the poisons. After the poison had been in contact with the soil for two hours, excess was washed out with 3×50 ml. lots of distilled water and the soil repercolated overnight either with 100 ml. distilled water or with 100 ml. of a $M/1{,}000$ solution of cupric, ferrous or manganous sulphate. The next morning this new percolate was again discarded and replaced by 100 ml. of $M/200$ ammonium chloride. The nitrite-nitrogen plus nitrate-nitrogen concentration in the percolate was thereafter estimated daily by phenoldisulphonic acid and the amount of nitrite-nitrogen plus nitrate-nitrogen formed per gram of soil calculated from the results.

The results from a number of different experiments show that all the four poisons tried reduced the rate of nitrification in soil. There is furthermore evidence that cupric, and perhaps ferrous, ions are capable of partially reversing the poisoning effect.

MICROGRAMS OF NITRITE PLUS NITRATE-NITROGEN FORMED IN TWO DAYS PER GRAM OF KENT MARSH SOIL

Poisoned with	Perfused overnight with Water	$CuSO_4$	$FeSO_4$	$MnSO_4$
$M/250$ potassium ethyl xanthate	tr.	120	50	70
$M/250$ sodium diethyl dithiocarbamate	20	220	50	20
$M/250$ salicylaldoxime	10	180	120	0
$M/250$ allylthiourea	50	50	50	50
Unpoisoned control	400	*	*	*

* A separate set of control experiments showed that the metal solutions themselves had no effect on the nitrification rate.

Experiments in which the oxidation of nitrite to nitrate by soil was studied separately gave results that showed a similar action of copper poisons on this process. The effect here was not, however, quite so strong.

The results suggest that copper and/or some allied elements play an important part in the oxidation of ammonium ions in soil by the soil microflora. Preliminary results obtained by Drs. Mann and Heintze in this laboratory show that the rate of oxidation of manganous ions may also be reduced by these same copper-enzyme poisons. Reactivation is, however, difficult here because of the toxic action of quite dilute copper solutions on manganese oxidation.

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Anti-Oxygen Stabilization of Bilirubin in Alkaline Medium by Ascorbic Acid and Cysteine

WE have shown in earlier publications[1,2] that ascorbic acid and cysteine prevent the oxidation of bilirubin in alkaline medium. The effect of both substances was ascribed hypothetically to their anti-oxygen properties. The mechanism of action of the anti-oxygen agents had not been elucidated. On the other hand, the protective action of ascorbic acid and cysteine for bilirubin might equally be explained as a reducing one. If such a view is valid, one would expect oxidized bilirubin to be promptly reduced in alkaline solution, when vitamin C or cysteine is added.

This hypothesis has been verified as follows: 10 mgm. bilirubin Hoffmann–La Roche, identical with Fischer's product, are dissolved in 500 c.c. $N/50$ sodium hydroxide. The oxidation of the pigment, which begins almost immediately, is characterized photometrically, as in previous experiments in collaboration with A. Lambrechts[3], by a continuous decrease of absorption in the region of 4300 A. 24 hours later, while the initial extinction coefficient at 4300 A. is 1·84 for a stabilized bilirubin solution, the oxidized bilirubin solution, on the contrary, shows a considerable decrease in its absorption, its extinction coefficient being 0·22. To two 100 c.c. samples of this oxidized bilirubin solution, we then add respectively 40 mgm. ascorbic acid and 94 mgm. cysteine hydrochloride neutralized by 10 per cent sodium hydroxide. These solutions are immediately examined by means of the Pulfrich photometer, and again after 3 and 6 hours. The accompanying table shows the photometric values recorded.

S.	Oxidized bilirubin + ascorbic acid			Oxidized bilirubin + cysteine		
	K immed.	K after 3 hr.	K after 6 hr.	K immed.	K after 3 hr.	K after 6 hr.
43	0·22	0·22	0·23	0·22	0·22	0·21
45	0·12	0·12	0·13	0·14	0·12	0·11
47	0·04	0·04	0·05	0·05	0·03	0·03
50–75	0·00	0·00	0·00	0·00	0·00	0·00

Conclusions. Ascorbic acid and cysteine do not reduce oxidized bilirubin in alkaline medium. It rather seems that both substances prevent directly the oxidation of bilirubin. In collaboration with R. Roseman[4], similar observations were made with some polyphenols easily oxidized in alkaline solutions. The experiments are being continued.

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Colour Receptors of the Human Fovea

AS soon as the results of Granit's micro-electrode experiments on the retinæ of animals were published, it was clear that a method was wanted for obtaining similar information with regard to the colour vision of man. This led to the development of the retinal micro-stimulator, which consists essentially of a microscope used in reverse, so that greatly diminished images of suitable test light-sources are presented to the eyes of the observer.

With apparatus of suitable design, it is possible to test, point by point, the colour vision of a chosen area of the retina. The dimensions I have used are such that each centimetre on the plotting-board of the apparatus corresponds with 'the cone intercentre distance', that is, the distance between the centre of one foveal cone and that of its next-door neighbours. It has been found possible to record the positions of the test light-sources with an accuracy corresponding to one tenth of this distance. A number of experiments have been performed with this technique, but those to be reported here concern the theories of colour vision. As is well known, Thomas Young's trichromatic theory postulated three colour sensations: red, green and blue. Granit, on the other hand, found in the retinæ of several types of mammals one 'dominator' and seven 'modulators'. The former was a sense-organ which responded to stimulation by light coming from most of the visible spectrum. The latter, on the contrary, were receptors with responses limited to a narrow part of the spectrum only. Granit found 'modulators' with maxima at the following wave-lengths in Angströms: 6000, 5800; 5400, 5200, 5000; 4600 and 4400. Thus, whereas the difference between two neighbouring units was usually two hundred Angströms, in two places the difference was double that amount, hence dividing them into three groups: yellow-orange, green and blue-violet.

Granit's conclusion was that each of the hypothetical 'sensations' of Thomas Young consisted of two or more kinds of 'modulator'. It should be pointed out, however, that whereas Granit's work has been performed on animals, Thomas Young's theory was intended to apply only to man. Physiologists are rightly cautious in such a case as this, for what is found with the former may differ widely from what is found with the latter.

The following results have been obtained. When white light from a small metal filament electric lamp is caused to move slowly over the fovea, as a narrow exploring pencil, in some places it appears red, in other places green, and in still other places blue. When red, it matches in colour a pencil of red light of 6400 A.; when green, it matches a pencil of green 5400 A.; and when blue, it matches blue of 4800 A. The precise position in the fovea of some of these specific points has been determined with reference to the point of fixation, by measuring the distance between the white test-light and the monochromatic light on which the gaze is fixed. Between these foveal points with specific colour responses are numerous other points having a non-specific response which may be either white or yellow.

A monochromatic orange light of 6200 A. is seen as red in some foveal positions, and as pale orange in others. Sometimes a minute black spot, due to the presence of an unstimulated receptor, is perceived. A monochromatic yellow light of 5800 A. behaves like a white light, in sometimes appearing white (or pale yellow), sometimes red, sometimes green and sometimes orange. A monochromatic green light of 5400 A. sometimes appears green, and sometimes very pale green or even white, as it is moved slowly from place to place over the fovea.

These experiments point to the following conclusions.

(1) Thomas Young's trichromatic theory of colour vision is substantially correct, since the above tests are held to prove the existence of red receptors, green receptors and blue receptors, in the human fovea.

(2) In addition to the receptors postulated by the above theory, there are either yellow receptors, white receptors, or both. In this respect the results so far obtained agree with the results obtained by Prof. Ragnar Granit who, as stated above, used the micro-electrode technique on the eyes of animals.

(3) Fixation can be extremely precise, since the effects of eye-movements do not show themselves.

(4) It is possible to stimulate by light, either single cones, or very small groups of cones indeed.

(5) It has been possible to identify, with the precision of at least half 'the cone intercentre distance', the position of some of the receptors which possess specific colour properties.

No evidence has so far been obtained that the green and blue sensations of human vision are due to the combined responses of several different kinds of receptor operating in narrow regions of the spectrum. It is hoped that further research with the microstimulator will help to elucidate this point.

I should like to thank Dr. John D'Silva, who acted as recorder for many of the above observations.

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Carcinogenic Substance from Human Cancer

J. F. MENKE[1] obtained lipid extracts from human breast cancer which, when injected into white mice, induced, in seven of thirty-six animals so treated, the development of sarcomas at the site of injection. In our experiments analogous extracts were prepared from various human cancers. Two extracts were prepared from gastric carcinoma, three extracts from breast carcinoma, and two extracts from fibrosarcoma. Each of the extracts was tested separately.

Four-months-old white mice of our own breeding were used in the experiments. Our strain of mice has a negligible incidence (less than 2 *pro mille*) of spontaneous tumours. The animals received 10, 20 or 30 mgm. of the lipid extract suspended in sweet almond oil, as a single subcutaneous injection. No differences were noted in the effect with variation of the doses within these limits. Of ninety-four mice injected with the extracts, twenty died within the first four months of the experiment. Of the remaining seventy-four mice, twenty-one animals (28·4 per cent) developed malignant tumours.

The tumours developed chiefly in organs at a distance from the site of injection, and exhibited various histological types including carcinoma and sarcoma. Gastric carcinoma extracts provoked two breast carcinomas (in two females), two lung lymphosarcomas (in one male and one female), and one lymphosarcoma at the site of injection (in one female). Breast carcinoma extracts provoked four breast carcinomas (in four females), one lung lymphosarcoma (in one female), one liver carcinoma (in one male) and two lymphosarcomas at the site of injection (in two females). Fibrosarcoma extracts provoked four breast carcinomas (in four females), one lung lymphosarcoma (in one female), one lung carcinoma (in one male), one kidney carcinoma (in one male), and one lymphosarcoma at the site of injection (in one female).

All seven extracts tested induced approximately the same percentage of tumours in the animals treated. The average period of time necessary for the development of tumours was 6 months for the gastric carcinoma extracts, 11 months for the breast carcinoma extracts, and 7·6 months for the fibrosarcoma extracts.

Of the fifty-three animals which died without developing tumours, the individuals survived as follows: four for 5 months, eight for 6 months, five for 7 months, seven for 8 months, four for 9 months, two for 10 months, two for 11 months, three for 12 months, and eighteen longer than 12 months.

Attempts undertaken with the aim of separating the active factor from the extracts resulted in a marked diminution of the number of malignant tumours provoked. Of fifty-seven mice injected with the chemically modified extracts, only six animals developed cancer. The average time for the development of the tumour after the single injection was approximately twice the time observed with the non-modified extracts.

Lipid carcinogenic extracts have been obtained from human livers[2-8] and from beef pituitary glands[9]. These experimental findings indicate that a lipid carcinogenic substance, probably of hormonal character, can be extracted from certain organs. Our experiments demonstrate that an analogous substance is present in human cancers. For this substance we propose the name 'boardin', which is accepted in our laboratories. Attempts are in progress to separate boardin from the extracts.

The histological diagnosis of the tumours was verified by Dr. Francis Carter Wood, to whom we are indebted for his co-operation.

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Transmission of *Litomosoides carinii* to Mice and Hamsters

Litomosoides carinii is a filariid parasite of the cotton rat, *Sigmodon hispidus*. It has been used extensively in the United States to investigate the chemotherapy of filarial infections. R. W. Williams and H. W. Brown[1] and J. A. Scott (private communication) have recently shown that infection was transmitted from one animal to another by means of the tropical rat mite *Liponyssus bacoti*. These workers kindly showed their results and methods to one of us and provided us with a colony of the mites and some infected cotton rats. Further infected cotton rats were kindly lent us by Prof. R. M. Gordon.

The transmission of *Litomosoides* to clean cotton rats and to laboratory (piebald) rats has been confirmed in this Institute, microfilariæ being found in the blood of the rats 63 days after the first exposure to infected mites. The blood of some of these rats has contained as many as 450,000 microfilariæ per c.c.

In addition, the attempt was made to transmit the infection to other laboratory animals. Nine albino mice were exposed to infected mites for 40–70 days. After 42 days, one mouse was killed and nine worms, measuring 5–14 mm. long, were found in the pleural cavity. The blood of the other mice was examined at somewhat irregular intervals. Microfilariæ were found in the blood of two mice, each on a single occasion, on the eighty-second and ninety-first days respectively after the beginning of the exposure to infection. No microfilariæ have been seen in the blood of the other six mice up to the ninetieth day. Three hamsters (*Cricetus* (*Mesocricetus*) *auratus*) were exposed to infection for periods of 26–44 days. One hamster died after 39 days; five worms, measuring 1–3·2 cm. long, both sexes being present, were found in the pleural cavities. Another hamster was killed after 44 days; the pleural cavities contained thirty-four worms, 1–3 cm. long, both sexes being present. In the case of the third hamster, microfilariæ were found at the first examination of the blood made on the seventieth day and on subsequent occasions, the number present being small.

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London, N.W.3. June 22.

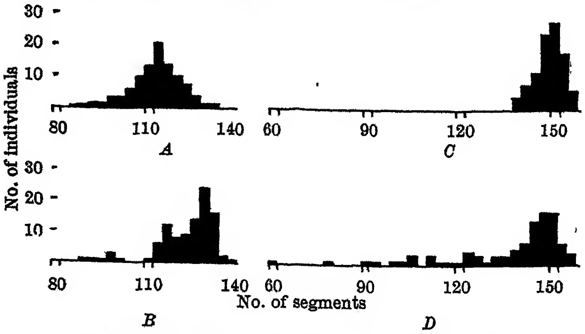
[1] Williams, R. W., and Brown, H. W., *Science*, **102**, 482 (1945); **103**, 224 (1946).

Distribution of Number of Segments in Earthworms and its Significance

DURING the course of an investigation into the relations between earthworms and the fertility of the soil, it has been found necessary to study the biology of the several species found in grassland in some detail since, in spite of their natural abundance, possible importance and extreme commonness as a type in zoological classes, very little is known about their biology, distribution on different types of soil, seasonal activities, etc. One of the factors making such a study difficult has been the fact that the specific characters are largely based on the position of the clitellum and tubercula pubertatis, which only appear at the onset of sexual maturity. Thus in a representative sample of worms only a small proportion are identifiable.

It has been the custom of systematists when describing species of earthworms to state the approximate number of segments, but little emphasis has ever been placed on this character. In an attempt to identify the numerous immature specimens collected during the past year, a detailed study has been made of the variation in the number of segments for a number of species. The results show that each species has a typical number often differing widely between nearly related members of the same genus, so that, taken in conjunction with other somewhat vague characteristics, about 95 per cent of the immature specimens in a collection can be identified. The departure of the distribution of the number of segments of adults from the normal distribution of the number for individuals just hatched can lead to interesting conclusions regarding the amount of predatism to which a species is subject, the presence or absence of regeneration in a species or genus, and finally an answer to a very old question, Do earthworms grow by adding segments?

The type of distribution of the number of segments varies considerably for the adults, from normal to an extremely left-skew distribution; that of individuals just hatched is, in general, normal or only slightly left-skew. As a result of predatism by birds and soil predators, a varying degree of left-skewness is introduced into the distribution, depending on the size of the species and on the possibility of regenera-



DISTRIBUTION OF THE NUMBER OF SEGMENTS OF 100 INDIVIDUALS

A, *A. chlorotica*, adult; *B*, *E. rosea*, adult; *C*, *L. terrestris*, recently hatched; *D*, *L. terrestris*, adult.

tion in the species. Thus for adults of *Allolobophora chlorotica* Sav., the distribution is normal; for *Eisenia rosea* Sav., it is significantly left-skew; and for *Lumbricus terrestris* Linn., highly significantly left-skew. In the cases of *A. chlorotica* and *E. rosea*, regeneration of the lost segments has mitigated the effect of predators on skewness, but in the case of *L. terrestris* (and two other members of this genus) regeneration of the lost segments does not seem to occur, with the result that the normal distribution for worms just hatched becomes more and more skew with increasing age.

Finally, the answer to the question, Do earthworms grow by adding segments?, is not the simple negative given by Sun and Pratt[1] but rather that some species possess the adult number of segments at hatching, in others the number of segments increases during growth and in the genus *Lumbricus* growth occurs in spite of a decrease in the mean number of segments with increasing age.

A full account of this work will be published later.

A. C. EVANS

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[1] Sun, K. H., and Pratt, K. C., *Amer. Nat.*, 65, 31 (1931).

Life-History of a Species of *Metapenaeus* in Australian Coastal Lakes

THE Penæid prawns, which are the basis of a valuable commercial fishery in the warmer countries of the world including, in particular, India, Australia, the Western Pacific and the southern shores of the United States, have a very special interest for zoologists.

This interest is bound up with the very remarkable fact that in opposition to all other Decapod Crustacea (including the common prawns and shrimps of northern Europe) the Penæid prawns do not carry their fertilized eggs under the abdomen but emit them into the sea, where they hatch out as typical nauplius larvæ.

The existence of this primitive type of development was discovered some years ago and aroused the curiosity of zoologists, but many years were to pass before even a moderately complete sequence of developmental stages could be directly associated with a known Penæid species.

Apart, however, from the scientific value of a knowledge of the larvæ, there is another reason for making special studies of the life-history of some of these Penæid species. To conserve any fishery it is essential to know the habits of the species concerned. The prawn fishery of the South Atlantic and Gulf coasts of the United States is the third in value of all fisheries of that eastern seaboard. The prawn industry of New South Wales, Australia, although not so valuable as that of the United States, is important, and up to a few years ago the scientific problem was made particularly interesting because the breeding habits of the favoured commercial species (*Penæus plebejus*, Hesse) were completely unknown. These prawns were very rarely caught with maturing gonads, and the few I obtained with well-developed gonads came from the ocean and the seaward margin of Port Jackson, whereas the prawn fishery is only carried on inside certain estuaries and in curious coastal lakes which are often cut off from the sea altogether for a year or more at a time.

Early in the year 1938, my first work dealing with the development of the well-known New South Wales commercial prawn, *Penæus plebejus*, was published[1]. It must be pointed out that our task was made rather difficult by the fact that it had to be proved first that this prawn left the estuaries and lakes and migrated to the ocean for breeding. There it was shown to increase in size to a remarkable extent as the gonads developed to maturity. This migration of *Penæus plebejus* was clearly demonstrated. The different larval stages had thus to be collected at sea where the larvæ of different species can easily confuse the issue.

Later in the same year an excellent memoir by Jeanne H. Heldt[2] appeared, which described more fully and definitely the life-history of certain Mediterranean species. The eggs of three species were set free from adults in the aquarium at Salammbo and hatching and rearing took place in aquaria.

To complete the coincidence of interest in Penæid research the year 1939 brought forward a publication giving the results of at least six years work by American authorities on their commercial species[3]. Apparently the American workers found similar migrations to the ocean and had to depend at first on plankton catches for material. Very satisfactory series of larvæ were obtained.

In the course of our early New South Wales investigations one species of Penæid (a species regarded at the time as of little or no importance in the fishery, and the existence of which was apparently unrecognized by some fishery authorities) was caught inside the shallow coastal lakes with gonads in a fair state of development. The exceptional fact was noted, but the war years prevented our obtaining any other specimens of this species at the breeding season. During the last twelve months an intense study of this species has not only led to the discovery of a fine series of the early stages but also has demonstrated that this Penæid actually becomes mature inside the shallow coastal lakes and breeds there.

The species (known locally as the 'greasy back') has usually been regarded as *Penæopsis monoceros* (Fabricius, 1798) or *Metapenæus monoceros* Alcock, a species of very wide range extending not only to India, but also, by migration through the Suez Canal, to the Mediterranean. However, there are some grounds, according to Burkenroad, for regarding the 'greasy back' of New South Wales as a new species of *Metapenæus*[4].

A complete account of the life-history is being published.

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[1] Dakin, W. J., *Proc. Zool. Soc., Lond.*, Ser. A, 108, Pt. 2 (1938). See also Dakin, W. J., *Records Aust. Mus.*, 20, No. 5 (1940).
[2] Heldt, Jeanne H., *Ann. l'institut oceanographique*, 18, Fasc. 2 (1938).
[3] Pearson, John C., *Bull. Bur. of Fisheries, Washington*, 49, Bull. 30.
[4] Burkenroad, Martin D., personal communication.

Relativity Transformations Connecting Two Systems in Arbitrary Acceleration

THE physical meaning of every term in the Lorentz transformation is now clear, thanks to the investigations of Einstein. Unfortunately, the general Lorentz transformations usually given as

$$\vec{r} = \vec{r'} + \vec{v}\,\frac{(\vec{v}\cdot\vec{r'})}{v^2}\left(\frac{1}{\sqrt{1-\beta^2}} - 1\right) + \vec{v}\,\frac{t'}{\sqrt{1-\beta^2}},$$

$$t = \frac{t' + \dfrac{1}{c^2}(\vec{v}\cdot\vec{r'})}{\sqrt{1-\beta^2}},$$

do not possess some of the beautiful properties of the original linear motion transformations owing to the non-group nature under successive velocity transformations and to the non-symmetry with respect to the space-time co-ordinates. I think something should be done about this.

After making clear the idea of contraction of length and clock and the misadjustment of the clocks, one is inclined to ask *when* the clocks and scales will be so contracted as the system *just starts* to move. Einstein did not trouble himself with this question as the system is, was and will always be in uniform motion, an idea handed down from Newton's time. It is therefore immaterial *when* it contracts or *when* the clocks are misadjusted. Students, however, usually come to me with the question as to whether the two ends of a rigid stick contract towards its centre. This is obviously not so, for many short sticks joined end to end would leave spaces between them after contraction, a fact certainly against the principle of relativity if not logic. Also, distant sticks cannot contract instantly as soon as the system starts to move, for no velocity of signalling can be greater than the velocity of light and there does not exist a rigid body system in relativity. A very, very long stick must have an enormous velocity at its ends in order to complete this contraction within the short interval during which the system attains its final velocity! To answer such and kindred paradoxes it is necessary to go back once more to the physical principles underlying the contraction and misadjustment of the clocks in the special theory of relativity. Take, for example, the synchronization problem treated by Einstein. The misadjustments of the clocks at different places of the moving system are due to the light signal connexions between places where clocks are to be synchronized; that is, the observers *did not and could not adjust their clocks instantly*. We certainly synchronize our clocks with, say, Greenwich by its constant radio signals and adjust our clocks by allowing for the time of travel. Our friends on the moving system would probably do the same thing and, being ignorant of their motion, have misadjusted their clocks! (The terms *rest* and *motion* here are only relative. But for the sake of clarity, we shall speak of a *moving* and a *rest* system as if it exists, and shall prove their relativity only afterwards.) Similarly, we find such effects in the apparent contractions of lengths and clocks. With this explanation, it is now possible to answer some perplexing problems encountered in Einstein's special relativity. The clocks, etc., are *apparently* affected through a *time delay*. Following this thought, we can work out the effects on clocks, etc., due to acceleration.

Since all the measuring standards along the light signal tracks emitted from the 'origin' of the moving system are affected similarly, according to the Lorentz formulæ with the instantaneous velocity of the 'origin', therefore

$$x - \xi = \frac{x' + v\,(t' - \tau')}{\sqrt{1-\beta^2}}\;;\quad t - \tau = \frac{t' - \tau' + \dfrac{v}{c^2}\,x'}{\sqrt{1-\beta^2}}\;;$$

where the primed letters refer to the moving system, unprimed to the rest system, and where $c(t-\tau)$ is simply the distance between an arbitrary point P, where the clock is to be synchronized with the origin, and the origin the velocity of which at time $\tau = t - r/c$ is v and acceleration Γ_x. The clock at the moving origin will register a time $\tau' = \int\sqrt{1-\beta^2}\,d\tau$ due to the successive Lorentz contractions. From them we obtain $r'/c = t' - \tau'$ and the differential coefficients:

$$dx = \frac{dx' + v\,dt'}{\sqrt{1-\beta^2}} + \frac{r'\Gamma_x}{c(1-\beta^2)(1-\beta_r)}\left(dt' - \frac{dr'}{c}\right);$$

$$dt = \frac{dt' + \dfrac{v}{c^2}\,dx'}{\sqrt{1-\beta^2}} + \frac{r'\Gamma_r}{c^2(1-\beta^2)(1-\beta_r)}\left(dt' - \frac{dr'}{c}\right);$$

where

$$\Gamma_x = \frac{dv}{d\tau}\,,\ \Gamma_r = \Gamma_x\,\frac{x-\xi}{r}\,,\ \beta_r = \frac{v}{c}\,\frac{x-\xi}{r},$$

and

$$d\tau = \frac{d\tau'}{\sqrt{1-\beta^2}} = \frac{dt' - \dfrac{dr'}{c}}{\sqrt{1-\beta^2}}.$$

The interpretations of these terms are interesting, but we shall only mention some practical applications here. From these transformation coefficients it is easy to obtain the electromagnetic field due to an

arbitrary moving charge from its Coulomb's field[1]. Strange to say, those obtained from this transformation agree perfectly with the field usually obtained through the solution of Maxwell's equations. This not only demonstrates that our physical idea is probably correct, but also shows how remarkable Maxwell's equations are, in perfect harmony even with this idea of relativity of acceleration. The inverse coefficients, solved from the above by determinant methods, should give the field as observed by an accelerated observer but due to a charge at rest. The results agree, using the apparent velocity and acceleration, beautifully with the field due to an accelerated charge. I think this can be experimentally verified. Can we now believe in the relativity of acceleration?

The contraction coefficients or effects are remarkable when we compare them with the results deduced from Einstein's principle of equivalence and his gravitation theory. But I believe the advance of the perihelion of Mercury and the deflexion of light beams can be obtained without the use of his theory of gravitation[2].

The relative nature of acceleration is apparent when we remember that at every instant the relativistic formulæ of Lorentz were used, that is, the motion has been relative all the time. The inverse transformation coefficients illustrate such relativity most clearly.

Some new difficulties come in when we assert the relative nature of acceleration. Acceleration is not like uniform motion, which Newton claims does not need any *cause* to maintain it. If I accelerate, I shall find that all the matter in the universe is accelerating towards me. What are the causes for such *en bloc* motions? (This difficulty also appears for uniform motion, though it is usually ignored. It is also strange for the *en bloc* uniform motion of all the matters in the universe *if* I move uniformly.) I shall not take Einstein's principle of equivalence as the answer, for it might equally well be asked where the gravitational field comes from, as gravitation must be caused by matter even in Einstein's general theory.

I cannot answer these questions at present (this paper is far from complete, and would not be presented for publication if not for the fact that our University is moving to Hangchow and will not settle down for at least six months), but I wish to point out that these *en bloc* accelerations are not quite true, and that the acceleration is not quite arbitrary as we may think at first when considering a man walking arbitrarily. Acceleration, as we know, is connected with the distance of the particle from other particles and 'a man walking' is an intricate macroscopic many-body problem. However, on multiplying the general $\partial t/\partial t'$ coefficient by m_0c^2,

$$m_0c^2 \frac{\partial t}{\partial t'} = \frac{m_0c^2}{\sqrt{1-\beta^2}} + \frac{r'm_0\Gamma_r}{(1-\beta^2)(1-\beta_r)} \doteq m_0c^2 + \frac{1}{2}m_0v^2 + r'F_r,$$

we see that it must be in the nature of energy. The first term corresponds to Einstein's kinetic and rest energy, the second term must correspond to potential energy. But the potential energy is ordinarily defined by an *integral* $V = -\int \vec{F}\cdot\vec{dr}$. For the two expressions to agree, it is necessary that, for small velocities and large distances,

$$V = rF_r = -\int \vec{F}\cdot\vec{dr}.$$

The only solution of this equation is $F = \lambda/r^2$, where λ is an arbitrary constant. Thus we see that the ordinary notion of force, at least in this specified inverse square law, is intimately connected with the relativity of acceleration, and there is really not much difficulty in getting rid of the idea of force altogether.

Finally, I wish to thank M. H. Wang, K. C. Chen and S. C. Kiang for collaboration and for their valuable suggestions. I must also thank Prof. K. C. Wang, Prof. T. L. Ho, both professors of physics in this University, Dr. Y. F. Tseng, deputy chief secretary to the Central Executive Committee, and my young brother Dr. C. P. Soh, publisher of the *Shanghai Herald*, for help and constant encouragement. To my brother especially, who has aided me financially, I tender my deep gratitude.

HSIN-PEI SOH

Department of Physics,
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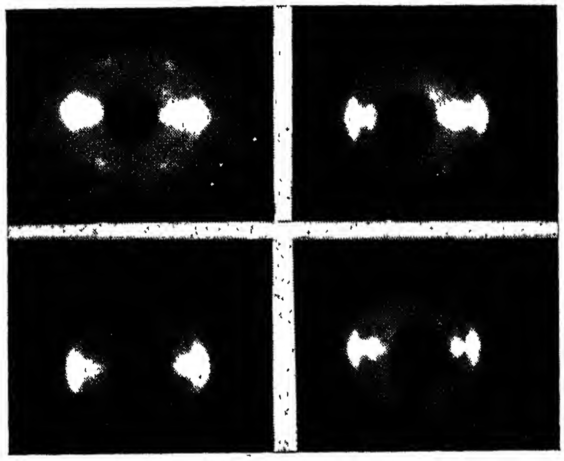
moving to Hangchow, Chekiang, China.
April 14.

[1] *Nature*, **157**, 809 (1946).
[2] Compare, for example, Cheng, *Nature*, **155**, 574 (1945), who considers only first-order *contraction* effects.

Effect of Dyeing, Mercerizing and Intensively Delignifying Jute Fibres on their Structure

THOUGH jute is a commercially important fibre, the study of its internal structure has not received so much attention as other cellulose fibres such as cotton and ramie. X-ray investigations of jute have recently been started in India. Banerjee and Roy[1] have found that the lattice structure of the cellulose crystallites in jute is identical with those in other cellulose fibres. The presence or absence of resins, fats and lignin does not produce any change in this structure. They have also found that the mean dimensions of the cellulose crystallites in jute are of the order of 62 A. along the fibre axis and 25 A. and 40 A. along the *a* and *c* axes respectively, so they are much smaller than those in ramie or cotton. The work is being carried out by Sircar, Rudra and Saha[2].

(*a*) (*b*)



(*c*) (*d*)

a, RAW JUTE DYED WITH CONGO RED. *b*, RAW JUTE DELIGNIFIED. *c*, RAW JUTE MERCERIZED AND DYED WITH METHYLENE BLUE. *d*, RAW JUTE DELIGNIFIED AND DYED WITH METHYLENE BLUE

X-ray photographs of jute fibres that have been subjected to intensive delignification have been taken by us. We have found that extensions of the spots take place so as to form arcs through them along the directions of the Debye–Scherrer rings. The positions of maximum intensity on the spots or their diffuseness along the radial direction are quite unaffected (Fig. 1*b*). This shows that lattice structure of the cellulose crystallites and their sizes are unaffected, while their ordering along the fibre axes has considerably deteriorated. The milder delignifications, however, as noted by the previous workers, do not produce this change. It is therefore concluded that a fraction of the lignin in jute helps to align the cellulose crystallites to parallelism and form bundles or fibrils of cellulose. This part of the lignin is much more difficult to remove than the remainder, in which apparently these fibrils are imbedded.

The effect of dyeing raw, completely delignified and partially mercerized jute fibres with Congo red and methylene blue has also been studied by X-rays. In the cases of raw (Fig. 1,*a*) and delignified jute fibres, it has been found that the X-ray pattern does not undergo any change, showing that the crystalline portion remains unmodified in structure as well as in alignment with respect to the fibre axis. It is particularly interesting that the dishevelling that is produced by the intensive delignification also remains unchanged (Fig. 1,*d*). This shows that the absorption of these organic dyestuffs is a superficial effect. Jute fibres treated with 25 per cent caustic soda solution at a temperature between 25° and 30° C. for half an hour showed diffraction spots corresponding to both native cellulose as well as mercerized cellulose. Dyeing by means of these organic dyestuffs also did not, in this case, produce any change in this partially mercerized structure (Fig. 1,*c*). So the crystallites of mercerized cellulose also are quite unaffected by the process of dyeing, both as regards internal structure as well as alignment.

We wish to thank Prof. K. Banerjee for suggesting the problem and for advice during the progress of the work.

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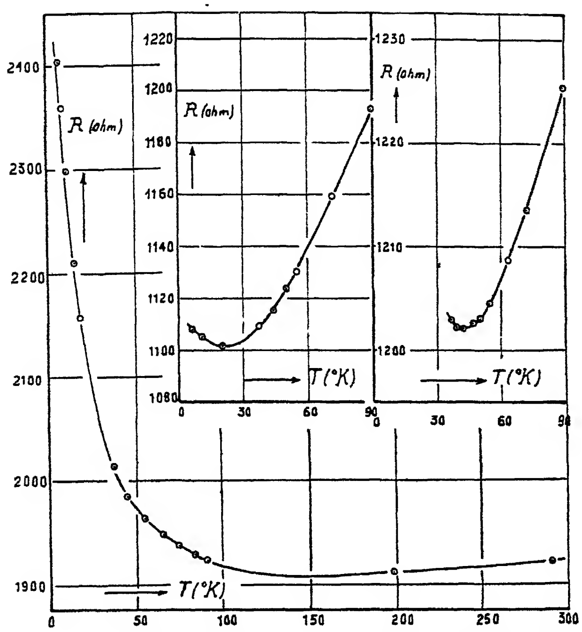
May 2.

[1] Banerjee, K., and Roy, A. K., *Proc. Nat. Inst. Sci. India*, **7**, 376 (1941).
[2] Sircar, S. C., Saha, N. N., and Rudra, R. M., *Proc. Nat. Inst. Sci. India*, **10**, 325 (1944).

Resistivity of Thin Nickel Films at Low Temperatures

IN an earlier communication[1], we reported on measurements on the electrical resistance of thin nickel films. We found at that time that for a thickness greater than 40 mμ the films possess a positive temperature coefficient, whereas for smaller thicknesses the temperature coefficient is negative. The films were made by cathodic sputtering.

We have now measured the resistance of such films as a function of temperature down to liquid helium temperatures. We were able actually to observe that, on cooling films thicker than 40 mμ down to very low temperatures, the electric resistance passes through a reversible minimum and the temperature coefficient changes from positive into negative. The nearer the thickness approaches to 40 mμ, the more the minimum in the resistance curve is displaced towards higher temperatures. So we were able to observe that for one resistance the minimum was in the neighbourhood of about 150° K. In the accompanying figure are curves obtained for three films showing minima in the resistance curve.



It is interesting to direct attention to the analogy existing between these results and the minima found by de Haas and van den Berg[2] for the resistance of gold wires at liquid helium temperatures.

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June 14.

[1] *Nature*, **156**, 634 (1945).
[2] *Physica*, **3**, 440 (1936); **4**, 663 (1937).

Additional Interference Fringes Produced by Scattering and Reflexion

IN a recent observation, F. K. Bauchwitz and D. Shoenberg[1] have reported observing a new interference effect. With the eye accommodated for infinity, they observed coloured circular fringes when looking at a strong point source through a thin air-film formed between silvered plates. The interpretation they give is that the light is first multiply reflected between the surfaces and then scattered, and this scattered light is multiply reflected before being observed.

The colours of thick plates which had been originally observed by Newton were interpreted by Young and by Stokes[2] in a similar manner to this, except that the interference pattern is produced by reflexion and not transmission. While preparing some optical flats a few years ago, interference patterns were noticed which differed from the usual Newton ring pattern and these were investigated. Experiments were carried out which showed that the patterns are produced by scattering and reflexion, and in the process the patterns seen by Bauchwitz and Shoenberg were independently observed as well as a double system of interference fringes, of which, to my knowledge, no previous description has been given.

This double system of fringes, consisting of a pair of patterns similar to the simple Newton ring type for thin plates, was photographed using the following experimental arrangement. Two optically flat glass plates about four inches in diameter were placed one on top of the other, the lower surface of the top plate was made semi-reflecting (semi-aluminized), the top surface of the lower plate being reflecting (fully aluminized). The scattering points were scratches on the semi-aluminized surface, or were simply produced by spreading a thin smear of oil over the surface with the finger. The flats were placed on the table and illuminated by a mercury lamp. The light from the source passed through a narrow slit (about 2 mm. wide) in a large black card, the plates being arranged so that the scratched lines were normal to the direction of the light. They were observed at an angle of 45° to the normal and two sets of interference patterns were visible. One set was localized in the plane of the surface of the half-aluminized plate, whereas the other pattern was localized in a curved surface close to the scattering surface. This latter pattern corresponds to the position of the Newton ring pattern formed by multiple reflexions as given by Feussner[3] and discussed by Tolansky[4]. It is suggested that the two fringe patterns are produced in the manner shown in Fig. 1*a* and 1*b*. The system of fringes indicated by Fig. 1*a* is localized in the scattering surface *C*, whereas the system corresponding to Fig. 1*b* for perfectly flat and parallel plates would be at an infinite distance. For the first set

$$(n_1 + \tfrac{1}{2})\lambda = 2d \cos\theta\,; \qquad (1)$$

and for the second set

$$(n_2 + \tfrac{1}{2})\lambda = 2d \cos\varphi. \qquad (2)$$

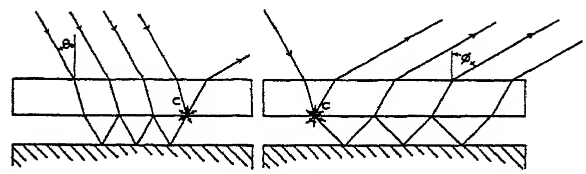
The interference pattern corresponding to the colours of thick plates is given by the summation of these two patterns, whence

$$(n_1 - n_2)\lambda = 2d\,(\cos\theta - \cos\varphi) \qquad (3)$$

Owing to the different locations of the two sets of fringes, it is difficult to photograph them together. Fig. 2 gives the general effect of the combination of the two patterns. The plates had been tilted so as to form a wedge angle, the two sets being then approximately straight lines inclined at slightly different angles. The intersection of these systems is clearly seen as bright and dark bands running across the photograph.

The above interpretation may be confirmed by holding a frosted plate in front of the two plates, when the pattern corresponding to the second system is seen. If the frosted plate is placed between the observer and the plates, a pattern similar to the first system is observed. These two patterns are usually distinctly different, for example, in one case a single interference colour pattern covered the diameter of the plate, and in the other the pattern consisted of several lines.

When the mercury lamp was replaced by a white-light source, the double system of fringes could not be distinguished; but a single system occurred which corresponded in position to the intersection of the two systems. This pattern corresponds to the pattern previously studied under the title of the colours of thick plates, and it is suggested that it is produced by the summation of the pair of interference patterns of the simpler Newton ring type.



a *b*

Fig. 1

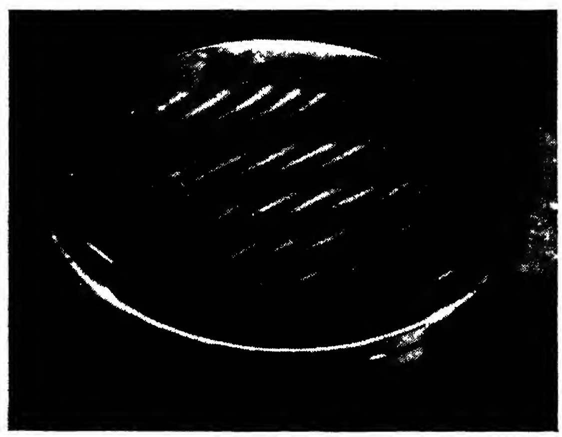


Fig. 2

In order to account for the colours of thick plates, Stokes came to the conclusion that it was necessary for two rays to be scattered from the same scattering element. He reached this conclusion as he was unable to observe the coloured pattern when he viewed a luminous point through a plate of glass, both surfaces of which possessed scattering centres. The alternative theory suggests that the colours are not produced by the diffraction effects at the scattering centres but by interference effects produced by reflexions between the plates, the scattering centres acting as secondary sources of light. The comparative faintness of the transmission pattern corresponding to the reflected pattern can be explained as follows. Since neither surface contained a reflecting layer, the intensity of the double set of interference patterns would be low and the resulting interference pattern difficult to see. These two patterns would be produced in a manner similar to that of transmission Newton ring patterns for thin plates. For glass surfaces that have not been made semi-reflecting these do not have the contrast of reflected interference patterns. The single-coloured pattern produced by a strong white light source can be readily observed, as was pointed out by Bauchwitz and Shoenberg, if the surfaces are heavily silvered. They may also be faintly observed on viewing a distant lamp through a glass plate one or both surfaces of which carries light scratches.

Further details of the experiments carried out were read last year to the Royal Society of Victoria[5] and are being published by that body.

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May 28.

[1] Bauchwitz, F. K., and Shoenberg, D., *Nature*, **156**, 142 (1945).
[2] Stokes, G., *Trans. Camb. Phil. Soc.*, **9**, 147 (1851).
[3] Feussner, Gehrcke, "Handbuch der Physik: Optik", 1 (1927).
[4] Tolansky, S., *Phil. Mag.*, vii, **35**, 120 (1944).
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CO-AMINOPHERASE, CO-DECARBOXYLASE AND PYRIDOXAL

ASPARTIC aminopherase from skeletal or heart muscle is readily dissociable and catalyses the transamination between *l*-aspartic and pyruvic acids in the presence of a dialysable co-enzyme[1]. Concentrates of this co-aminopherase have been prepared from pig heart by us and the substance has been shown to be acid-labile[2]. Glutamic aminopherase is not inactivated by dialysis. Attempts of Cohen[3] and Lènard and Straub to activate this enzyme with thermostable factors are based upon misinterpretation of the suggestion that glutamic aminopherase might contain a difficultly dissociable prosthetic group similar to co-aspartic-aminopherase[1].

Suggestive evidence pointing to a possible relationship between the prosthetic group of aminopherase and the 'pseudopyridoxin' factors—pyridoxal and pyridoxamine—has been reported by Snell[4,5,6], who demonstrated the non-enzymatic transamination reaction:

$$\text{Glutamic acid} + \text{pyridoxal} = \alpha\text{-ketoglutaric acid} + \text{pyridoxamine}$$

in model experiments[5]. Schlenk and Snell[6] report that the glutamic aminopherase activity of the tissues is lowered in vitamin B_6-deficient rats and can be restored by administration of pyridoxin. *In vitro* reactivation of glutamic aminopherase by the addition of pyridoxal in the presence of adenosinetriphosphate was slight and irregular. Gunsalus, Bellamy and Umbreit[7] and Baddiley and Gale[8] have shown that the coenzyme of the bacterial amino-acid decarboxylases[9] is replaceable by, and probably identical with, phosphorylated pyridoxal. Cohen and Lichstein[10] found no significant decrease in the transaminase activity (glutamic→aspartic) of *S. fæcalis* R. grown in pyridoxin-deficient media; but Lichstein, Gunsalus and Umbreit[11] repeated the work under more exacting conditions and showed that such organisms have in fact markedly decreased transaminase activity, which can be restored to normal by the addition of pyridoxal phosphate to the washed suspensions. These workers also obtained a cell-free preparation containing active transaminase from *S. fæcalis* and showed that it could be reversibly resolved into apo-enzyme and a co-enzyme moiety which could be replaced by pyridoxal phosphate. Green, Leloir and Nocito[12] obtained a purified preparation of transaminase from pig heart and, although they were unable to resolve the enzyme, showed that boiled preparations can replace the coenzyme portion of 'dopa' decarboxylase which can be replaced, in turn, by pyridoxal phosphate or Gale's codecarboxylase[9].

With the view of elucidating the mutual relations between phosphopyridoxal and the coenzymes of transamination and of amino-acid decarboxylases, we made an arrangement with Dr. E. F. Gale of Cambridge to perform comparative assays of the two coenzymes and of pyridoxal phosphate with the respective apo-enzymes and substrates. In this note we report the results of preliminary assays of the activity towards apo-aspartic-aminopherase in the transamination reaction *l*-aspartic acid→*l*-alanine with the following co-factors (Table 1):

A. Co-aspartic-aminopherase concentrate[2]; 0·02 ml. corresponds to 1 gm. pig heart muscle.

B. Lead salt of concentrate of natural codecarboxylase, kindly supplied by Dr. Gale, who states that 1 mgm. of lead salt is equivalent to 6 μgm. of barium-pyridoxal-phosphate when assayed against tyrosine apo-decarboxylase.

C. Synthetic pyridoxal phosphate as its barium salt, prepared by Gunsalus *et al.*[13] and obtained from Prof. Gunsalus through Dr. Gale. The preparation contains little impurity and 32 per cent pyridoxal[13].

D. Preparation *A* was subjected to extraction with phenol and the extracted material precipitated as a lead salt, 1 mgm. being equivalent to 0·025 ml. concentrate *A*. This procedure follows steps in the purification of codecarboxylase[9].

E. Boiled solutions of highly purified glutamic aminopherase prepared according to Lènard and Straub[14]; 1 mgm. of the enzyme formed 18 mgm. pyruvic acid from alanine and ketoglutarate in 15 min. which corresponds to 18 Lènard–Straub units. Dr. Gale kindly informed us that 6 mgm. of this boiled enzyme were equivalent to 0·6 μgm. of barium-pyridoxal phosphate (*C*) in the tyrosine decarboxylase test and to 0·37 μgm. pyridoxin in a microbiological assay effected by Dr. M. Chance of Glaxo Laboratories.

F. Pyridoxal hydrochloride (courtesy of Dr. E. E. Snell) in the presence of adenosine-triphosphate and pig-heart press-juice activated by autolysis at 0° and dialysed[1].

TABLE 1

TEST SAMPLES CONTAINED IN A TOTAL VOLUME OF 6 ML., 4 ML. APO-ASPARTIC-AMINOPHERASE, 200 μMOL. *l*-ASPARTIC ACID, 200 μMOL. PYRUVIC ACID, PHOSPHATE BUFFER *p*H 7·4 AND COFACTORS AS INDICATED BELOW. SAMPLES WERE INCUBATED AT 37° FOR 1½ HR. AND ANALYSED FOR ALANINE BY THE METHOD OF FROMAGEOT AND HEITZ[15]

Exp. No.	Alanine formed in control without cofactors (μmol./sample)	Alanine formed in excess of control (μmol./sample) in presence of:									
		ml. co-aminopherase *A*				mgm. codecarboxylase *B*					
		0·01	0·02	0·04	0·06	0·2	0·4	0·5	0·6	0·8	1·0
1	0	38	46	50	—	12	—	14·6	—	37	54·5
2	13	38	37	78	—	5	—	7	28	36	46
3	0	28	30	44	52	—	—	28	—	—	—
4	25	—	—	—	—	10	36	50	30	28	15
						μgm. phosphopyridoxal *C*					
						5	10	20	20 (no pyruvate)		
5	36	—	25	54	65	0	8	10	0		
6	15	3	40	50	—	5	10	15			
		Boiled glutamic aminopherase *E* 108 units equivalent to 6 mgm.				co-aminopherase extract *D*					
						1 mgm.			2 mgm.		
7	20	0				0			7		
8	0	0				—			5		

It can be seen from Table 1 that the partially purified natural codecarboxylase (*B*) is fairly active in the aspartic-aminopherase system, 1 mgm. of the lead salt being approximately equivalent to 0·02–0·04 ml. of co-aspartic-aminopherase concentrate *A*. In contrast to this, comparatively large amounts of phosphopyridoxal or of co-aminopherase *A* after extraction with phenol and lead precipitation (*D*) show only slight doubtful activity. Boiled glutamic aminopherase is inactive as cofactor. A similarly low degree of activation was obtained in dialysed heart press-juice with either phosphopyridoxal or pyridoxal plus adenosine triphosphate (Table 2).

From our results it would appear that the coenzyme system of mammalian aspartic aminopherase is either different from, or more complex than, phosphopyridoxal. The system is present in the codecarboxylase preparation. In attempts to supplement co-aspartic-aminopherase after inactivation by 20 min. boiling with 0·1 *N* sulphuric acid, by the addition of

TABLE 2. EXPERIMENTS WITH DIALYSED HEART JUICE

Exp. No.	Alanine formed in control without co-factors (μmol.)	Alanine formed in excess of control (μmol.) in presence of:				
		100 μgm. pyridoxal + 2·5mgm. ATP	20μgm.(C) phospho-pyridoxal	Co-asp-artic-amino-pherase	Inactivated co-aspartic-aminopherase alone	Inactivated co-aspartic-aminopherase + 20μgm.C
9	25	10 10·2	14	55	14	28
10	25	11 12	5	46	5 4	12

phosphopyridoxal, we obtained only a simple additivity of the small activation increments due to the separate cofactors (Table 2).

The experiments are being continued.

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ARRANGEMENTS were made with Prof. Braunstein, as indicated in his letter above, to carry out comparative assays of codecarboxylase, coaminopherase and barium-phosphopyridoxal preparations against aspartic-aminopherase on one hand and tyrosine decarboxylase on the other. For assay of tyrosine codecarboxylase activity, tyrosine decarboxylase was prepared from *S. fœcalis* cells and the apo-enzyme made by precipitation with ammoniacal ammonium sulphate solution followed by standing at 0° as described by Epps[16]. We are indebted to Prof. I. C. Gunsalus for a sample of highly purified synthetic barium-phosphopyridoxal[13], and a standard curve was obtained relating the activity of the tyrosine enzyme to the concentration of phosphopyridoxal. An amount of apo-enzyme preparation was chosen which would give 220 µl. carbon dioxide from tyrosine in 5 min. at 30° and *p*H 5·5 when saturated with coenzyme; the corresponding value in the absence of added coenzyme was 4 µl./5 min. and the rate of carbon dioxide evolution bears a linear relation to phosphopyridoxal concentration for quantities of the latter up to 0·4 µgm. barium salt per 3 ml. ($\equiv$ 140 µl. carbon dioxide per 5 min.). For assay purposes amounts of the various cofactors were taken which would give rise to carbon dioxide evolution under the standard conditions of not more than 140 µl./5 min. and the equivalence of barium-phosphopyridoxal read off directly from the standard curve.

Table 3 gives some of the results obtained. A lead salt of natural codecarboxylase concentrate was prepared as previously described[9]; 1 mgm. proved to be equivalent to 6·0 µgm. barium-phosphopyridoxal. In this case comparative assays were also carried out using lysine apo-decarboxylase[17] when 1 mgm. of lead salt proved equivalent to 5·3 µgm. barium-phosphopyridoxal. Co-aspartic-aminopherase was received from Prof. Braunstein as three preparations. $A(a)$ was a solution of the concentrate[2], $A(b)$ a dry lead salt prepared from $A(a)$ after extraction into phenol, and $A(c)$ a freeze-dried preparation of $A(a)$. The solution $A(a)$ had very little activity in the tyrosine decarboxylase system; this little activity seemed to have survived in the lead-salt $A(b)$, but 1 ml. of the co-aminopherase concentrate proved to be equivalent to 0·05 µgm. barium-phosphopyridoxal only. It is possible that these preparations had suffered some deterioration, as the freeze-dried preparation

TABLE 3. TYROSINE CODECARBOXYLASE ACTIVITIES OF PREPARATIONS WARBURG FLASKS CONTAIN 1·5 ML. $M/5$ CITRATE-PHOSPHATE BUFFER *p*H 5·5, 0·3 ML. TYROSINE APO-DECARBOXYLASE PREPARATION, CO-ENZYME PREPARATION AND/OR WATER TO TOTAL VOLUME 2·5 ML. SIDE-BULBS CONTAIN 0·5 ML. $M/15$ *l*-TYROSINE SUSPENSION, TIPPED AFTER 15 MIN. EQUILIBRATION. CARBON DIOXIDE EVOLUTION MEASURED AT 30° C.

Preparation	Quantity	µl.CO_2/ 5 min.	Equivalence of barium phosphopyridoxal (µgm.)
Ba-phospho-pyridoxal (C)	None	4	
	0 1 µgm.	37	
	0 2	68	
	0·3	106	
	0·4	150	
	0·6	179	
	1·2	216	
	3·0	220	
Pb-salt of codecarboxylase (B)	0·01 mgm.	24	0 06
	0·03	60	0·18
	0·05	96	0·28
	0·1	188	0·62
	1·0	—	6 0
Co-aspartic-aminopherase	0·2 ml.	11	0 02
(a) solution A	0·5	11	0 02
(b) Pb-salt D	5 mgm.	11	0·02
10 mgm. = 1 ml. A	10	22	0·05
(c) Prep. A	0·1 ml.	11	0·02
freeze-dried	0 3	22	0·05
	0·5	32	0 09
	1·0	—	0·18
Glutamic aminopherase (E)			
(a) Freeze-dried;	0·1 ml.	75	0·21
boiled before	0·2	122	0·35
assay.	0·3	142	0·42
1 ml. = 117 units = 6 mgm.	1·0	—	2·1
(b) Boiled at	0·5 ml.	116	0·33
*p*H 7 before	0 5	110	0·315
freeze-dried	1·0	—	0·65
1 ml. = 108 units = 6 mgm.			

$A(c)$ gave an equivalence of 0·18 µgm. barium-phosphopyridoxal/ml.

From the results shown above in Prof. Braunstein's communication, it can be seen that 1 ml. of coaminopherase concentrate A is equivalent to approximately 2,000 µgm. barium-phosphopyridoxal in the aspartic-aminopherase system. Further, although codecarboxylase (B) is active in the aspartic-aminopherase system, it has there an equivalence of 0·02–0·03 ml. co-aspartic-aminopherase (A) per mgm. compared with an equivalence of approximately 30 ml. co-aspartic aminopherase per mgm. assayed in the tyrosine decarboxylase system. These results indicate that coaminopherase is not identical with phosphopyridoxal although the natural codecarboxylase concentrate possesses some coaminopherase activity.

Glutamic aminopherase. Preparations of glutamic aminopherase were received from Prof. Braunstein in two forms: $E(a)$ consisted of a preparation containing 117 Lènard–Straub transaminase units per ml.; this had been freeze-dried in the active state. Prof. Braunstein states that the activity after drying had fallen to 70 units per ml. The preparations had not been dialysed and contained ammonium sulphate, but the activity indicated a protein content of about 6 mgm./ml. Before assay in the tyrosine decarboxylase system, the contents of each ampoule (= 1 ml. original preparation) were dissolved in 1·0 ml. of $N/100$ caustic soda and boiled for 5 min. to liberate codecarboxylase[9]. Assays were carried out on the complete boiled material after neutralization to *p*H 5·5. The material was markedly active as codecarboxylase, 1 ml. of $E(a)$ having an equivalence of 2·1 µgm. barium-phosphopyridoxal. In further samples, the enzyme preparation had been dialysed and 1 ml. samples (= 6 mgm. enzyme) boiled at *p*H 7 before freeze-drying. For assay these samples were

dissolved in water and tested directly; 1 ml. of this preparation had an equivalence of 0·65 μgm. barium-phosphopyridoxal. Other samples which had been boiled at pH 4 or 8 showed further deterioration.

Green, Leloir and Nocito[12] prepared two transaminating enzymes from pig heart, one carrying out a transamination from glutamic acid to α-ketoglutaric and the other from glutamic acid to pyruvic acid. This second enzyme is presumably the same as glutamic aminopherase of Braunstein. Green *et al.* found that the pure enzyme contained codecarboxylase as a constituent of the preparation, and it can be calculated from the figures in their paper that 1 mgm. of the purest enzyme preparation contained 0·269 μgm. phosphopyridoxal when assayed against 'dopa' decarboxylase. Prof. Braunstein stated in a letter to us that the transamination Q of his preparation was approximately 18,000 compared with an activity of 29,000 for the highest attainable purity according to Lènard and Straub. Consequently the assay value of 0·18 μgm. phosphopyridoxal per mgm. enzyme (*Ea* Table 3) compares very well with that obtained by Green *et al.*

We are indebted to members of the Science Department of the British Council for arranging the transfer of material between Cambridge and Moscow.

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Reversible Splitting of Glutamic Aminopherase

Two enzyme systems catalysing the transamination of amino-acids have been prepared from muscle and heart tissue and described by one of us (M.K.)[1,2]. These enzymes were termed glutamic aminopherase and aspartic aminopherase, according to their specific primary substrates[3]. The latter is easily inactivated in the initial stages of purification (dialysis, etc.), and can be reactivated by a thermostable coenzyme present in boiled tissue extracts[4]; while the former can be prepared from muscle tissue without loss of activity.

In a preliminary note[5] it was suggested that glutamic aminopherase might contain a prosthetic group less readily dissociable than that of aspartic aminopherase. Recently we obtained experimental data indicating that glutamic aminopherase prepared by the method of Lènard and Straub[6] (stage B) can be inactivated reversibly by acidification to about pH 2·8 or alkalization (in a broad range near pH 10–11), followed by dialysis. Part of the enzyme is inactivated irreversibly, depending upon the degree of acidity or alkalinity. The inactivated enzyme (= apo-enzyme) can be reactivated to some extent by the addition of boiled muscle (or liver) extract. The degree of reactivation ranges from 20 to 70 per cent, as shown in the accompanying table, averaging 37 per cent, and 30 per cent upon acid- and alkaline-splitting respectively.

DECREASE OR FORMATION OF PYRUVATE[6] IN μMOL. PER ML. ENZYME (ABOUT 100 LENARD–STRAUB UNITS).
COMPOSITION OF TEST SAMPLES AND EXPERIMENTAL CONDITIONS WERE THE SAME AS IN AMINOPHERASE ACTIVITY DETERMINATIONS ACCORDING TO LENARD–STRAUB[6]. ENZYME PREPARED JAN. 4, 1946.

Date of experiment	Initial amount of pyruvate or α-keto-glutarate	Disappearance or formation of pyruvate in 15 minutes (μ-mol.)			
		Activity of untreated enzyme	Residual activity of tested apo-enzyme	Additional activity with boiled tissue extract	Reactivation %
		Split by acidification (pH 2·8)			
	Pyruvate				
8·1	300	78	0	26	33
16·1	307	101	0	28	27
19·1	388	129	0	44	34
23·1	311	117	0	81	70
	α-keto-glutarate				
25·1	259	98	0	26	26
29·1	269	196	0	75	38
		Split by alkalization (pH 10–11)			
16·111	320	113	85	33	28
18·111	,,	88	74	32	43
,,	,,	88	74	17	20

In some experiments prolonged dialysis against distilled water or buffer solutions of different pH also resulted in partially reversible inactivation of the enzyme.

Negative results were obtained in attempts to reactivate apo-glutamic aminopherase by the addition of co-aspartic aminopherase concentrate, co-decarboxylase or phosphopyridoxal[4], and by flavine-adenine-dinucleotide or thiamine.

The nature of the active group of glutamic aminopherase is under investigation.

Addendum by cable received May 25. We have reported above on the reversible splitting of glutamic aminopherase prepared according to Lènard–Straub, stage B; tissue Kochsaft reactivated the apo-enzyme. Further investigation showed that a purer preparation of this enzyme (Lènard's stage D) is split more readily upon acidification and dialysis. Reactivation can be effected by addition of Kochsaft or of 1–5 μgm. phosphopyridoxal. Larger quantities, 10–25 μgm., phosphopyridoxal fail to activate the enzyme. Our negative results with phosphopyridoxal were due to the inhibitory action of the excessive concentrations employed.

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RECENT LOW-TEMPERATURE RESEARCH AT THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

THE fourth meeting of the Low Temperature Group of the Physical Society was held on May 15 in the Department of Chemical Engineering and Applied Chemistry, Imperial College, when the work of the Department in the field of low-temperature technology was described and the laboratories and equipment were open to inspection by members of the Group. The head of the Department, Sir Alfred Egerton (who is also chairman of the Low Temperature Group), describing the origin of his interest in low-temperature technology, said that in a country where petrol is not indigenous, as much use as possible should be made of the hydrocarbon methane, which can be made available in unlimited quantities from coal. One use that is feasible is as a fuel for internal combustion engines. The best way to carry methane on motor-vehicles is as a liquid in vacuum-jacketed tanks, at approximately atmospheric pressure and normal boiling point, $-161 \cdot 4^{\circ}$ C.

During the War a variety of problems connected with this subject were attacked and solved, to the point where it would have been possible, if required, to produce cheap liquid methane on a large scale and to provide motor-vehicles with reliable equipment which would permit the use of either petrol or liquid methane, according to which was available. The cost of liquid methane from coal gases would not be so low as that of petrol, but it could be competitive with other liquid fuels produced from coal. In some countries where natural gas or waste vegetation are sources of methane, the liquid could be produced at quite a low cost.

The work at the Imperial College included the design and construction of a pilot methane liquefier and a liquid methane rectifying-column, the design of vacuum-jacketed vehicle tanks and of equipment for feeding the liquid to the engine, and tests on engine performance and wear. In addition, numerous laboratory investigations were carried out on the vapour-liquid phase equilibria of mixtures containing methane; the heat transfer coefficients of methane and other gases under forced convection at low temperatures; the measurement of thermal conductivities of insulating materials at low temperatures; the measurement of heat radiation from various metal surfaces from the point of view of their incorporation in vacuum-jacketed vessels; the solubilities in water of methane, carbon dioxide, and their mixtures under pressure, and the fire-hazards attendant upon the use of liquid methane on vehicles.

With the end of the War and the end of restrictions on the Department's activities, the scope of the work was extended. A laboratory liquid-air plant utilizing Freon-12 as a pre-cooling fluid has been designed and is now being constructed. A method of purifying gases from small quantities of condensable constituents by the injection of a stream of cold pure gas is being tried out, and experiments are in progress to determine the factors influencing the adhesion of frozen particles to tube walls. Both these investigations derive from the general problem of the purification of industrial gases prior to liquefaction. An apparatus has been constructed for the determination of the latent heat of vaporization of binary mixtures at low temperatures and pressures above atmospheric; and an investigation is in progress on the properties of lubricants at low temperatures.

Calculations and experiments have been made on the extraction by refrigeration of olefines and methane from coal or coke-oven gases, the first being of use in chemical synthesis, the second in the form of liquid, as a thermal reservoir to meet peak loads on town-gas undertakings. The methane would be extracted and stored as liquid at periods of low demand, and re-gasified to enrich water gas at periods of high demand.

The experimental work of the Department was exhibited to the Low Temperature Group, and the various activities were discussed in greater detail in the course of short addresses given by Sir Alfred Egerton, Prof. D. M. Newitt, Mr. M. Pearce and Dr. T. A. Hall, on the storage of liquefied gases, on the unexplored regions of the temperature-entropy diagram, and on the purification and separation of constituents of coal and coke-oven gas by liquefaction.

IMPORTANCE OF TAXONOMY

IN the course of his final presidential address to the Linnean Society on May 24, Mr. A. D. Cotton took occasion to emphasize the importance of taxonomy and the need of securing additional workers in this branch of biology.

Speaking of the distribution of the Dendrosenecios on the equatorial mountains of Africa, he said it was the impossibility of reconciling the records of the species on Kilimanjaro and on other mountains which led him to take up the study of the group. Many records existed in systematic literature; and ecologists and others used these records for their field work and in their published papers. When he came to study them he was confronted by a state of affairs only too familiar to all experienced taxonomists. Except where new species are concerned, no record, whether in floristic or ecological literature, could be accepted at its face value. This casts no reflexion on the botanists of the past. The fact illustrates the slow growth and evolution of a difficult branch of botanical science and demonstrates the imperative need for further taxonomic research and of a more intensive type.

Mr. Cotton does not maintain that the classification he has prepared is perfect or final, because much more field work is necessary; but with the aid of as much co-operation as possible in the field and by examination of all herbarium material extant, it is believed to be reasonably correct.

The Linnean Society is the one Society which, from its inception to this day, has cared for general taxonomy, and at the present time, when the subject tends to be overshadowed by other branches of biology, the Linnean Society has never shrunk from bearing the very heavy expense of publication of systematic papers even to the serious depletion of its funds. Systematic papers are not usually suitable for reading at meetings but are prepared for use and for reference. They have a permanent value not often attained by other papers. The Society aims at being broad in its interests, but one of its principal functions is the publication of such papers for the benefit of botanists and zoologists throughout the world. Taxonomic work and its publication is, in fact, in large measure, essentially a service.

There is no doubt that the standard of taxonomy needs to be raised aloft. Looking back over a period of twenty years, during which he has been in charge of a great systematic institution, Mr. Cotton has become acutely conscious of the need of recruits to this branch of biology. Unless such recruits be forthcoming, and in considerable numbers, the immense floras and faunas of the world can never be properly understood. Only those who have worked with such world floras and faunas have any conception of their magnitude and their riches in genera and species.

Ecology and cytology naturally make a strong appeal also to the present-day student not only on account of their intrinsic interest but also because of their suitability for short-term research and research theses: but their very interest and glamour is apt to lead to the less exciting, more exacting, but all-important work of taxonomy being passed by. It may even fall into disrepute among those who do not realize the value of taxonomy, or who think only in terms of nineteenth-century systematics. Mr. Cotton therefore appealed to the young biologist to consider seriously the claims of this branch of science. There can be no question of the need for a greater number of professional taxonomists. The flora or handbook which the ecologist or economic botanist demands when he takes up a Colonial appointment can only be prepared after years of patient labour in a systematic institution, while more fortunate colleagues who carry out researches on such subjects as physiology and genetics require correctly named material or they may find their results at variance with those of other workers.

Mr. Cotton pointed out that this emphasis on the importance of taxonomy was not made on account of personal preference but from a sense of responsibility and a desire to serve the interests of biologists as a whole.

METHODS AND RESULTS OF NUTRITION SURVEYS

IN October 1944, the Nutrition Society set up a Standing Advisory Committee "for co-ordination of methods of survey in liberated territories". Advantage was taken of the fact that there was in Britain at that time a large number of scientific workers from enemy-occupied countries, and three representative panels were set up to report on: (1) laboratory methods; (2) clinical methods; (3) methods of survey of food consumption.

Certainly some agreement on terminology, methods of investigation and ways of presenting results is badly needed, particularly for the first two. As things stand, it is difficult to compare one person's findings with another's, with any assurance that the measurements made do, in fact, provide a true basis for comparison.

Two of the three panels (the first and the third) presented reports in August 1945*. It would be very valuable if the Nutrition Society would now add a short note on the experiences since gained by investigators while putting the recommendations into practice. Has any modification been required, and if so, what? Have any other techniques been evolved or found more practicable?

Choice of method for any investigation is inevitably limited by the facilities available. The Laboratory Methods Panel has recognized this and has limited its recommendations accordingly. Estimations of hæmoglobin and of proteins in plasma or serum are dealt with very fully, and tests of vitamin C status are described; but comment on "the assessment of level of nutrition with regard to B-vitamins" is limited to a short description of the principles and relevant literature, since "the biochemical evaluation of the nutritional status of the B-vitamins requires elaborate equipment and special chemicals".

It appears that the main difficulties in reaching any uniformity of meaning in past surveys have been due to: (1) differences in methods used; (2) differences in assumptions on which calculations were based; (3) differences in standards used; (4) personal factors; (5) errors in instruments; (6) differences in methods of expressing results.

Accordingly, among the recommendations made, the Panel suggests: (1) that apparatus used should be standardized; (2) that results should be expressed in absolute units and in the decimal system; (3) that methods in which subjective errors may be large should be avoided.

In addition to critical reviews of estimation methods mentioned above, there are "general recommendations with regard to taking samples of blood" and a detailed table putting together the results of a very large number of surveys dealing with hæmoglobin-levels, all of which had been conducted under conditions meeting with the requirements of the Panel. Other tables set out results of surveys showing protein levels in serum or plasma in healthy persons and under conditions of nutritional œdema.

The report ends with details of working methods and a "comparison of results obtained by various methods with those obtained by measurement with other methods used as standards". A list of references is included.

The Food Consumption Panel had a problem of a different nature to face. Provided facilities are available, laboratory investigators have a straightforward job; but dietary surveys are always complicated by the fact that collection of data for analysis depends to a very large extent on obtaining full co-operation from the individuals being surveyed. At the best of times this is difficult to ensure; under the unsettled conditions immediately following liberation of enemy-occupied countries, it must have been still more difficult. Where there are food shortages and the inevitable 'black market', investigators must necessarily be regarded with suspicion, if not with fear. In territories where the administration is in the hands of strangers, the local population is usually inclined to blame them for all difficulties and shortages, and investigators belonging to such an administration may find it virtually impossible to establish the necessary confidence.

The Panel recognized that such difficulties would exist, and it is stated that "investigators should be provided with letters of authority and preferably with a photograph. Arrangements should be made with the local burgomaster and police to establish the credentials of each investigator and ensure her protection if necessary." It would be interesting to know how this has worked out in practice; my own experience is that the more informal and unofficial

* Standing Advisory Committee for Co-ordination of Methods of Survey in Liberated Territories. Recommendations with Regard to Methods of Investigation of Nutrition. Pp. 67. Dietary Panel: Methods for Dietary Survey. Pp. 23. (London: Bureau of Nutrition Surveys, London Hospital, E.1, 1945.)

the contact between investigator and investigated, the more readily the information is obtained and the more complete it appears to be.

The Panel proposed that four kinds of dietary surveys should be made—"of (1) the family, (2) individuals, (3) the consumption of individual foods, and (4) institutions and works canteens". Two methods of family studies are described in detail: (*a*) a questionnaire method, and (*b*) the log-book method. The first of these is largely a test of the housewife's memory (in addition to her willingness to tell); the second requires her to keep detailed records, with the investigator checking every second day following the initial recording of stores. For individual intake records, a measurement-at-table technique is described.

These methods were used successfully in Britain even during the War, but conditions in newly liberated territories must surely have been very different. The Panel goes on to state that "it is important that sufficient clerical staff is available to keep the analyses of the data well in hand", it suggests that "each household might be surveyed for at least a fortnight and whenever practicable for four weeks", and it talks of a "team of thirty to forty investigators together with four supervisors", and the establishment of a central organisation for Hollerith work analysing the survey data.

The report would, in my opinion, have gained in value if it had included a description of methods which could be applied when such facilities are not available and under conditions where form-filling co-operation cannot be expected (after all, it is not only the illiterate who find difficulty in filling in forms accurately). However, it may be that the Panel—apparently thinking in terms of Europe only—was able satisfactorily to forecast the conditions and facilities which were actually found. It would now be useful and interesting to know.

The report on "Nutrient Values of European Foodstuffs During the War", prepared by the Combined Working Party on European Food Supplies, is included as an appendix. M. W. GRANT

GLACIER OSCILLATIONS IN THE NORTHERN AND SOUTHERN HEMISPHERES

THE Report of the Committee on Glaciers for 1945 (*Trans. Amer. Geophys. Union*, 27, 219; 1946) contains much valuable data on glacier variations in the United States and Peru, together with an outline of the general pattern of glacier histories in the two hemispheres.

Prior to 1850, European glaciers had been oscillating forward and backward at frequent intervals, the major advances being the greatest since the end of the Pleistocene. Since 1850, however, recession has been dominant, although interrupted by a moderate re-advance around 1890 and by local smaller advances between 1910 and the early 1930's. The recession has proceeded by successive stages of increasing rapidity, with marked acceleration during the last decade. In the western United States recession has also been dominant since the 1850's, and although some glaciers made feeble and brief re-advances during the 1920's and early 1930's, on the whole the rate of recession has accelerated up to the present time.

The glaciers of New Zealand lost enormously in length and thickness between the 1860's, when the first observations were made, and the early 1890's, when they regained much of their volume. Small temporary re-advances have been noted during about 1906–34, but since then the glaciers have again been wasting away, at an increasing rate which has recently been quite abnormal. The Peruvian glaciers have shared an almost parallel history since the 1860's, again including a phase of accelerating shrinkage since 1932.

Thus in both hemispheres there has been dominant shrinkage during the last eighty or ninety years, with rather close synchronization of some of the variations and especially of the remarkable accelerating recession of recent years.

Among the inferences drawn from the evidence passed in review by the Committee on Glaciers, the following are of far-reaching significance:

(*a*) The causative climatic variations have affected both hemispheres simultaneously and not in alternation.

(*b*) It is therefore reasonable to suppose that the more pronounced post-Pleistocene variations and the major Pleistocene variations were also synchronous in the two hemispheres.

(*c*) Whatever the causes of these climatic variations may be, their world synchronism rules out all 'astronomical theories', such as those of Croll, Spitaler and Milankovitch, that require refrigeration of one hemisphere and simultaneous warming of the other. The mathematical verity of these theories is not impugned, but it is evident that the causes of climatic change which they postulate are subordinate to other more potent causes, the nature of which is still undetermined.

(*d*) Calculations of glacio-eustatic changes of sea-level that are based on the assumption of synchronous glaciation and synchronous deglaciation in both hemispheres are essentially sound in principle.

FORTHCOMING EVENTS

Tuesday, July 23

ROYAL ANTHROPOLOGICAL INSTITUTE (joint meeting with the SOCIETY OF ANTIQUARIES OF LONDON and the UNIVERSITY OF LONDON INSTITUTE OF ARCHÆOLOGY, at University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. L. S. B. Leakey: "The Acheulean Site of Olorgasailie, Kenya".

Thursday, July 25

BRITISH ASSOCIATION (joint meeting of Section L (Education) and the Division for the Social and International Relations of Science, at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 10.30 a.m.—Conference on "UNESCO and Universities".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Emmanuel de Margerie: "Three Stages in the Evolution of Alpine Geology—Saussure, Studer, Heim" (Second William Smith Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER AND DEMONSTRATOR IN BOTANY, a LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT, a LECTURER IN THE MATHEMATICS DEPARTMENT, a SENIOR LECTURER IN PRODUCTION ENGINEERING, a LECTURER IN THE NATURAL PHILOSOPHY DEPARTMENT, and DEMONSTRATORS (2) IN THE DEPARTMENT OF PHARMACY—The Secretary, Royal Technical College, Glasgow (July 27).

LECTURER IN CHEMISTRY at the Coventry Technical College—The Director of Education, Education Offices, Coventry (July 27).

JUNIOR LECTURER IN ELECTRICAL ENGINEERING—The Clerk and Treasurer, Dundee Technical College, Bell Street, Dundee (July 27).

SENIOR LECTURERS (2) IN MATHEMATICS in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (July 30).

LECTURER and an ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, University College, Southampton (July 31).

LECTURER IN CHEMISTRY in the Burnley Municipal College—The Director of Education, Education Offices, Burnley (July 31).

LECTURER IN ELECTRICAL ENGINEERING—The Secretary of University Court, The University, Glasgow (July 31).

ASSISTANT LECTURER IN PHARMACOGNOSY—The Registrar, University College, Nottingham (July 31).

LECTURER IN GEOGRAPHY at the United College—The Secretary, The University, St. Andrews (July 31).

PRINCIPAL SCIENTIFIC OFFICER in the Ministry of Supply to deal with specialized aspects of research, development and design connected with Artillery and Armoured Fighting Vehicles—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1538 (August 1).

RESEARCH ASSISTANT IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (August 3).

RESEARCH ASSISTANT IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Leeds (August 5).

LECTURERS IN THE DEPARTMENTS OF (a) BOTANY (2), Ref. G.239; (b) GEOGRAPHY, Ref. G.240; (c) GEOLOGY, Ref. G.241; (d) ZOOLOGY, Ref. G.242; (e) APPLIED MATHEMATICS, Ref. A.204; (f) PHYSICS, Ref. A.205, and (g) PURE MATHEMATICS, Ref. A.206; University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 8).

LECTURER (ungraded) IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool (August 21).

LECTURER IN GEOGRAPHY—The Secretary, The University, Aberdeen (August 24).

UNIVERSITY READERSHIP IN THEORETICAL PHYSICS at Birkbeck College—The Academic Registrar, University of London, Senate House, W.C.1 (August 27).

ASSISTANT LECTURER IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Sheffield (August 31).

ASSISTANT LECTURER (Grade III) IN APPLIED MATHEMATICS—The Registrar, The University, Liverpool (September 1).

UNIVERSITY CHAIR OF MEDICINE at the British Post-Graduate Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 3).

CHAIR OF PHYSICS at Royal Holloway College—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 5).

READER IN PHARMACOLOGY AND EXPERIMENTAL PHYSIOLOGY in the Department of Physiology, Medical School, King's College—The Registrar, University Office, 23 St. Thomas' Street, Newcastle-upon-Tyne 1 (September 7).

CHAIR OF CIVIL ENGINEERING, CHAIR OF ELECTRICAL ENGINEERING and the CHAIR OF MECHANICAL ENGINEERING, in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (Melbourne, September 15).

DIRECTOR, ROAD RESEARCH INSTITUTE, to be established in India—The Secretary, Council of Scientific and Industrial Research, The Mall, Delhi, India (September 30).

BEYER CHAIR OF ENGINEERING—The Registrar, The University, Manchester 13 (November 1).

LECTURER IN THE DEPARTMENT OF ANATOMY AND EMBRYOLOGY—The Secretary, University College, Gower Street, London, W.C.1.

SCIENTISTS (well qualified), with research and/or teaching and administrative experience, for the British Council Cultural Scientific Office in China—The British Council, Appointments Department, 3 Hanover Street, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Methods of Test for Transport Gas Producer Fuels. (British Standard 1264: 1945.) Pp. 28. (London: British Standards Institution, 1945.) 2*s*. net. [101

Recommended Methods for Polarographic and Spectrographic Analysis of High Purity Zinc and Zinc Alloys for Die Casting. (British Standard 1225: 1945.) Pp. 36. (London: British Standards Institution, 1945.) 2*s*. net. [161

Ministry of Agriculture and Fisheries. Bulletin 132: Cabbages, Brussels Sprouts and Miscellaneous Green Crops. Pp. ii + 30 + 8 plates. (London: H.M. Stationery Office, 1945.) 1*s*. net. [181

The United Nations Charter. A Commentary by David Mitrany, Gilbert Murray, G. D. H. Cole, Norman Bentwich, Rita Hinden, and the Text. (Peace Aims Pamphlet, 31.) Pp. 56. (London: National Peace Council, 1946.) 1*s*. [181

British Rubber Producers' Research Association. Publication 64: Research on Pneumatic Tyres for Farm Tractors. Report of Work carried out in 1939–40 by the Institute for Research in Agricultural Engineering, University of Oxford, for the British Rubber Producers' Research Association. Pp. 32. (London: British Rubber Producers' Research Association, 1945.) 2*s*. [181

Petroleum at War. (Reprinted from the *Petroleum Times*.) Pp. 36. (London: *Petroleum Times*, 1945.) 4*s*. [181

Ministry of Health. Nurses Salaries Committee: Mental Nurses Sub-Committee. Further Recommendations. Mental Nurses S.C. Notes, No. 5. Pp. 6. (London: H.M. Stationery Office, 1946.) 1*d*. net. [281

The Pattern of Pacific Security. A Report by a Chatham House Study Group. Pp. 73. (London and New York: Royal Institute of International Affairs, 1946.) 2*s*. 6*d*. net. [281

University of Cambridge. Annual Report of the Solar Physics Committee. Pp. 2. (Cambridge: The University, 1945.) [291

Association of Special Libraries and Information Bureaux. Report of Proceedings of the Twentieth Conference held at Portland Hall, the Polytechnic, London, W.1, September 15 and 16, 1945. Pp. 112. (London: Association of Special Libraries and Information Bureaux, 1945.) 6*s*. [291

Railway Engineering Abstracts, Nos. 1–184. Vol. 1, No. 1, January–February 1946. Pp. 48. (London: Institution of Civil Engineers, 1946.) 7*s*.; annual subscription, 35*s*. [52

University of Leeds. Report of the Librarian for the Session 1944–45. Pp. 6. (Leeds: The University, 1946.) [52

City and Guilds of London Institute. Report of the Council to the Members of the Institute for the Year 1944. Pp. 49. (London: Gresham College, 1945.) [52

Other Countries

Indian Forest Leaflets. No. 56: Quality of Charcoal Produced in Indigenous Kilns. By A. C. Dey and B. S. Varma. Pp. ii + 4. 4 annas; 6*d*. No. 70: Common Latex Bearing Woody Plants of India. By K. L. Budhiraja and R. Beri. Pp. ii + 18. 6 annas. No. 72: The Vegetable Tanning Materials of India, Part 1. Survey. By R. L. Badhwar, A. C. Dey and M. V. Edwards. Pp. ii + 40. 8 annas. (Dehra Dun: Forest Research Institute, 1944.) [1912

Indian Forest Bulletin, No. 125: A Note on the Insect Borers of Bamboos and their Control. By J. C. M. Gardner. Pp. 16 + 3 plates. (Dehra Dun: Forest Research Institute, 1945.) 12 annas. [1912

South Australia: Institute of Medical and Veterinary Science. Seventh Annual Report of the Council, July 1944–June 1945. Pp. 16. (Adelaide: Institute of Medical and Veterinary Science, 1945.) [31

A Trip Through the New Building of Mellon Institute. Third edition. Pp. 20. (Pittsburgh, Pa.: Mellon Institute, 1945.) [31

Western Australia: Department of Mines. Report of the Government Geologist for the Year 1943. Pp. 32. Report of the Geological Survey for the Years 1941 and 1942. Pp. 13. (Perth: Government Printer, 1944.) [31

Food and Irrigation Problems affecting India in General and Bombay in Particular. By Rao Bahadur N. S. Joshi. Pp. 68. (Poona: The Author, 1287 Shivaji-Nagar, 1945.) [31

Yale Anthropological Studies. Vol. 2: Outline of Cultural Materials. Prepared by George P. Murdock, Chellan S. Ford, Alfred E. Hudson, Raymond Kennedy, Leo W. Simmons and John W. M. Whiting. Pp. vii + 56. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1945.) 6*s*. 6*d*. net. [31

Gold Coast Colony. Report on the Forestry Department for the Year 1944–45. Pp. 8. (Accra: Government Printing Department; London: Crown Agents for the Colonies, 1945.) 1*s*. [81

Administration Report of the Government Mineralogist for 1944. By L. J. D. Fernando. Pp. 12. (Colombo: Department of Mineralogy, 1945.) [81

League of Nations. Report on the Work of the League during the War. (Official No.: A.6.1946.) Pp. 167. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1945.) 2*s*. [81

Ministry of Finance, Egypt: Survey Department. Survey Department Paper No. 48: Survey Tables. By J. H. Cole. Pp. ix + 77. (Cairo: Government Press, 1945.) [81

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 18. Pp. v + 70. (Paris: Presses universitaires de France, 1940.) [81

Twenty-eighth Annual Report of the National Research Council of Canada, 1944–1945. Pp. 40. (Ottawa: National Research Council of Canada, 1945.) [91

Report of the Danish Biological Station to the Ministry of Agriculture and Fisheries. 44, 1939. By Dr. H. Blegvad. Pp. 24. 45, 1940. By Dr. H. Blegvad. Pp. 69. 46, 1941. By Dr. H. Blegvad. Pp. 36. 47, 1942. By Dr. H. Blegvad. Pp. 46. (Copenhagen: C. A. Reitzel, 1940–1945.) [91

Svenska Hydrografisk-Biologiska Kommissionens Fyrskepps-undersökning år 1942–1943. Pp. 46. (Göteborg: Elanders Boktryckeri A.-B., 1945.) [91

Sveriges Geologiska Undersökning. Ser. Ca, No. 33: A General Earth Magnetic Investigation of Sweden carried out during the Period 1928–1934 by the Geological Survey of Sweden. Part 3: Horizontal Intensity. By Kurt Molin. Pp. 105 + 4 plates. 10 kr. Ser. Ca, No. 34: A General Earth Magnetic Investigation of Sweden carried out during the Period 1928–1934 by the Geological Survey of Sweden. Part 4: Vertical Intensity and Horizontal Disturbing Force. By Kurt Molin. Pp. 104 + 5 plates. 10 kr. Ser. Ca, No. 35: De mellansvenska järnmalmernas geologi. Av Per Geijer och Nils H. Magnusson. Pp. 654 + 56 plates. 25 kr. (Stockholm: P. A. Norstedt and Söner, 1941–1944.) [91

Carlsberg Foundation's Oceanographical Expedition round the World 1928–30 and previous *Dana* Expeditions. *Dana* Report No. 22: Indo-Pacific Leptocephalids of the Genus *Anguilla*; Systematic and Biological Studies. By Poul Jespersen. Pp. 128 + 4 plates. (Copenhagen: C. A. Reitzels Forlag; London: Oxford University Press, 1942.) 24 kr.; 20*s*. [101

Denkschriften der Schweizerischen Naturforschen Gesellschaft. Band 74, Abh. 2: Beiträge zur Kenntnis der Dipluren und Thysanuren der Schweiz. Von Peter W. Wygodzinsky. Pp. v + 113–228 + 10 plates. Band 74, Abh. 3: La pression de radiation et le coefficient de diminution d'énergie dans les étoiles. Par G. Tiercy. Pp. 229–244. Band 74, Abh. 4: Neue Untersuchungen über den Föhn in den Schweizer Alpen. Von R. Streiff-Becker. Pp. v + 245–278. Band 74, Abh. 5: Camp d'Aérologie Alpine des Rochers-de-Naye, 1939; Rapport de la Commission d'Aérologie Alpine. Rédaction: W. Eichenberger. Pp. vi + 279–332. Band 75, Abh. 1: Studien zur vergleichenden Morphologie der Vögel, 1: Über das embryonale und postembryonale Hirnwachstum bei Hühnern und Sperlingsvögeln. Von Ernst Sutter. Pp. viii + 110. Band 75, Abh. 2: Beitrag zur Gletscherkunde Forschungen am Claridenfirn im Kt. Glarus. Von R. Streiff-Becker. Pp. v + 111–132. (Zürich: Gebrüder Fretz A.G., 1941–1943.) [101

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 22, No. 3: The Bird Fauna of Rio Juruá in Western Brazil. By Nils Gyldenstolpe. Pp. 338. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1945.) [101

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LIBRARIES AND RESEARCH NEEDS

THE University and Research Section of the Library Association has now formulated proposals regarding the post-war development of the university and research libraries of Great Britain. These proposals overlap in some respects the recommendations of the Council of the Association made in consequence of Mr. L. R. McColvin's report on "The Public Library System of Great Britain", but also deal with a group of libraries, some of which come within the scope of the former proposals and almost all of which are of special interest to the man of science. Reviewing the place of the university and research libraries in a national system, and considering in succession the national and the local organisation of book resources for research, the new report* will be carefully studied by all who recognize the importance of scientific and technical books as tools for industrial research, apart altogether from the wider field which they present for research in the arts, the humanities and the social sciences. Its recommendations, which have already been adopted by the Council of the Association, are in substantial agreement with the recommendations of the earlier report where they overlap, and they represent developments which the Council considers are needed to enable the university and research libraries of Great Britain to carry out their work efficiently and to make their full contribution to the national life.

The libraries with which this report is concerned differ widely in age, in size and in scope, and have in common only their function of supplying materials for the advancement of knowledge. Some of them, like the university and university college libraries, are the property of the bodies they exist to serve, and the interests of those bodies have naturally a first claim on their services. Almost without exception, the university libraries, however, have recognized that a part of the service which a university owes to the community is to make available, within the measure of its means, and to those qualified to make use of them, such of its library resources as are not available elsewhere. Other libraries which are also the property of corporate bodies, such as the learned, scientific and professional societies, industrial research associations, Government departments, firms and newspapers, owe their services to the bodies which establish and maintain them, and need feel less obligation than the university libraries to the outside public. For much specialized literature they are the obvious and often the only source of supply. But while a firm's library clearly could not make its resources generally available, all these libraries have rendered much more assistance to outsiders than any statistics can show, and many libraries in both these groups have, as 'outliers' of the National Central Library, placed their resources fully at the disposal of those who need them.

* Library Association. University and Research Libraries of Great Britain: their Post-War Development. Pp. 16. (Library Association, Chaucer House, Malet Street, London, W.C.1, 1946.)

While these libraries have already shown that they are willing to undertake obligations as part of the organised book resources of Great Britain, it must be remembered that they are rightly proud of their independence, which for practical reasons also they would be most unwilling to surrender. Moreover, many even of the university libraries are neither staffed nor equipped to handle easily the mechanical side of any considerable expansion in the inter-library lending through the National Central Library. The abnormal conditions of the last few years, with the interruption to runs of European scientific and technical periodicals and the scarcity of copies reaching Great Britain, have put a premium on lending books and periodicals, which has severely strained such resources as these and like libraries possess for dealing with merely the packing and postage involved.

If these libraries are to undertake obligations as part of the organised book-resources of Great Britain, due regard must be had to such circumstances. Like considerations to a certain extent may apply to a further group of Government libraries, such as the British Museum or the Science Library, the primary obligations of which are not to a particular department but to the public in general. Finally, there is the group of great municipal reference libraries, including commercial and technical libraries, which in contents, staffing, organisation and function have for long been a very important part of the country's resources for research. Apart from definite schemes for co-operation which they have initiated, as at Sheffield, such libraries have always welcomed readers outside the boundaries of their authorities, and more recently they have made their resources available for inter-library lending as freely and profitably as the university and special libraries.

Outside all these groups stands the National Central Library, the organisational work of which has made possible the utilization of their resources, and the collections of which, though limited by financial stringency and damaged during the War, are not unimportant. The development of the National Central Library in the last thirty years out of the Central Library for Students does not appear to be well known to scientific workers, although its Information Department, which is concerned with applications for books not available in its Library Department, and traces them and arranges for their loan, can be a research tool of the first importance. Apart from the fact that the National Central Library's collections are intended to supplement existing provision, on the ground of the services of the Information Department alone there is ample reason for implementing the recommendation of the McColvin Report that the National Central Library should be recognized as an integral part of the national system, and guaranteed a reasonable permanent means of existence and the wherewithal to plan for the future and for whatever developments the well-being of the country demands.

The address on the National Central Library which Mr. R. H. Hill gave to the London and Home Counties Branch of the Library Association at Brighton on October 6, 1945 (*Library Association Record*, December 1945), should be of interest to scientific workers who wish to form an opinion as to the place of the National Central Library in the nation's system of libraries for research, and it will be noted that in the present report the Library Association urges more adequate financial support for it. In making this recommendation, the report has in mind not merely the work of the National Central Library in administering the whole system of inter-library lending which it is assumed will be continued and extended as the indispensable basis of the proposed developments, but also that the importance of its own resources for research will increase.

The principal recommendation of the Library Association's report, however, is a survey of library resources in Britain for research. This, it is urged, is the first step to secure the fuller co-ordination required in the interests of economy and of efficiency, but which is at present hampered by uncertainty as to how far the different fields of knowledge are covered by different libraries. To supply this information, to show library administrators where the country's collection of books is redundant and where it is deficient, and to show the reader where he will find the collections most useful for his purpose, are the prime objectives of the survey. Much of the material for such a survey is probably already in possession of the National Central Library and of the Association of Special Libraries and Information Bureaux, and the report suggests that a co-operative scheme should aim at providing for every subject or group of subjects at least two collections as complete as possible, one from which books are never lent, and one of books available for loan.

Similar surveys locally in each region of Great Britain are also recommended and might lead to even closer co-operation. The report instances, for example, the organisation of a reference and a loan set of the Public Record Office publications, the Sheffield scheme for pooling technical periodicals and the local collection of local literature. A survey is also desirable of the many old endowed libraries, such as those of cathedrals, parishes, churches, colleges and schools. Some of these are admirably catalogued and well known, while others are little known and inaccessible. For such a survey a special committee would be required to offer advice where needed on questions of cataloguing and preservation. Production of a short directory of such libraries, as a first objective, might be followed by a series of uniform catalogues or a union catalogue. A union catalogue has already been undertaken for books earlier than 1700 in cathedral libraries. This aspect of the survey obviously closely touches the work of the British Records Association and the Historical Manuscripts Commission in establishing the National Register of Archives.

The report recommends that all libraries agreeing to take part in the national and local systems of library co-operation should be eligible for a share in any public funds which may become available for the provision of books. While such grants would involve guarantees that they were rightly expended,

and in particular that they were not used in relief of the normal library expenditure of the institution, they would not interfere with the independent administration of the libraries, and, as already indicated, the report stresses the necessity of retaining the present system of voluntary co-operation of independent institutions. The preliminary survey of national resources would involve a certain expenditure, but it is not anticipated that the developments proposed would involve much additional finance. The building of the collections indicated as necessary would be achieved in part by the better direction of existing expenditure which the survey itself would make possible, though it is suggested that the survey would probably point to the desirability of further expenditure on periodicals at the Science Library.

These are the main features in the report of interest to scientific workers. There is some discussion of the professional aspects of work in research libraries, such as the qualifications of staff, salaries and training; but the report is one which deserves attention by all who realize the extent to which books form the primary or ancillary material for the prosecution of research, and the consequent necessity for adequate supplies of books in the many fields of industry, commerce, education and administration.

It would not be claimed that the proposed survey of national book resources is the only direction in which co-operation between libraries, and indeed between libraries and the users of libraries, is desirable or possible. The increased contacts which may result from the survey may well be expected, for example, to stimulate two developments which are long overdue in Great Britain, and which would be of immense service to the reader and buyer of books, whether private or for a library, and in stimulating the browsing and wide reading which is such a fruitful habit for the student and research worker to acquire. The first of these is the production in Britain of something corresponding to the *Quarterly Book List* which has been issued in the United States since 1945 by the Superintendent of Documents, United States Government Printing Office. This list is produced under the guidance of an advisory committee with Mr. L. H. Evans, librarian of Congress, as chairman, and including representatives of such bodies as the National Research Council, the Army Medical Library, the American Council of Learned Societies, the Social Science Research Council, the American Library Association and the American Council on Education. The *List* originated in a recommendation of the Inter-American Conference for the Maintenance of Peace, held in Buenos Aires in 1936, and in promptitude of publication and the authority of its annotations is far ahead of the *Aslib Quarterly Book List*, which is all that is available in Great Britain to replace the British Science Guild's "Catalogue of British Scientific and Technical Books", last published in 1930. The United States *Quarterly Book List* gives the names and occupation of its contributors, but the annotations are unsigned because the Library of Congress assumes full responsibility for all material appearing in the *List*. While it is highly selective and neither comprehensive nor exhaustive, it should be invaluable to those wishing to keep abreast of current contributions of the United States in the fields of the fine arts, literature, philosophy and religion, biography, the social sciences, the biological sciences, the physical sciences, and technology. Merely from the point of view of national prestige, a production of like quality in Britain is desirable.

The second development is a matter which more closely concerns the universities themselves and on which Bruce Truscot just touched in his "Redbrick University"; and although he discusses the question of reading, books and libraries more fully in the freshman's guide, "First Year at the University", just published, he does not quite get to the heart of the matter—the priceless value of really good bookshops as a stimulus to the book buying and browsing for which he pleads. The contrast in this respect between Oxford and Cambridge and some of the towns in which 'Redbrick University' is located is almost unbelievable; and if by some means of co-operation between librarians and publishers, the standard of bookshops accessible to provincial universities could be raised to something approaching that which prevails in Oxford and Cambridge or in London and Edinburgh, for example, a real service would be done to learning. Meanwhile, it may well be hoped that publication of this report by the Library Association will not only stimulate initiation of a survey of the national library resources for research, but will also promote co-operation between libraries and librarians of all types, locally as well as nationally. Creative thinking and clear definition of objectives are essential for the successful launching of practical schemes which will ensure a more adequate supply of the books which are the essential tools of research and their most efficient handling from the broadest point of view.

A CRYSTALLOGRAPHIC APPROACH TO STEREOCHEMISTRY

Grundlagen der Stereochemie

Von Prof. Paul Niggli. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, Chemische Reihe, Band 1.) Pp. 283. (Basel: Verlag Birkhäuser, 1945.) 32.50 francs.

With the detailed problems of classical stereochemistry developed first in organic chemistry under van't Hoff and Le Bel, and twenty years later in inorganic chemistry under Werner, this book is not directly concerned. It is not a text-book of stereochemistry, but rather a presentation of the fundamental principles on which a comprehensive stereochemistry can be developed. The author's distinguished contributions to the geometrical theory of crystal structure and to mineralogy are well known. In recent years the highly successful developments of crystal chemistry, particularly in the direction of the silicates and other mineral structures, have added to and deepened this background. Consequently it is not surprising if the treatment is found to follow lines perhaps unfamiliar, but nevertheless very stimulating, to the chemist.

Niggli feels that the earlier attempts to solve the general problem of the spatial distribution of atoms in compounds were rendered more difficult, and failed to achieve general applicability, because of the failure to distinguish clearly between the study of the *position* which atoms take up and the *forces* which cause them to assume and retain these positions. Accordingly, some thirty years ago, he undertook the development of a stereochemistry which should embrace organic as well as inorganic radicals, and crystals as well as molecules. He considers that the stereochemical behaviour of atoms can only be satisfactorily treated after a rigidly idealized investigation of the symmetry relations has been undertaken; and only when the various possibilities have been systematically classified is it worth while investigating the causes which lead to the observed arrangements. The fact that quite similar structures have been found to result from totally different bond types shows the essential accuracy of this approach to the problem. On the other hand, valency ideas developed from the frequent occurrence of simple stoichiometric ratios, while they undoubtedly achieved success over wide areas of chemistry, actually retarded the development of those other areas—alloys, natural silicates, etc.—which could not be adequately classified by valency ideas alone.

Accordingly, more than half the present book is taken up with the development of a general theory of the symmetry of molecular and point configurations. In this the general terminology and methods of crystallography are used. Now, mathematical crystallography is a beautifully simple and complete science, because it deals with the limited number of symmetry types which are applicable to infinite but periodic structures based on a regular lattice. The importance of such a study in crystal chemistry, where the whole crystal is effectively the molecule, cannot be over-estimated. But it is more difficult to grasp its application to that self-contained group of atoms which the chemist usually associates with the word 'molecule'. Nearly all such chemical molecules, including even the complex viruses, may conform to the laws of crystallography if they have the opportunity of arranging themselves regularly in space; but this does not necessarily help us any better to understand the infinite complexity of the atomic arrangement in the molecule itself.

Only later on in the book does the author consider the combining capacities of atoms, devoting attention continually to the necessity for clear definition of the terms which are used. In his view there is no fundamental distinction between homogeneous combination as in graphite and diamond, and heterogeneous combination as in boron nitride and zinc blende. In discussing many other structures, often on the lines of Pauling, he introduces a form of representation of electron distribution which is both easy to read and is free from the appearance of a static electron which the familiar noughts-and-crosses method might suggest. This may be illustrated by his formulation of carbon dioxide as

$$\frac{4}{1}\,\mathrm{O}\,\frac{4}{2}\,\mathrm{C}\,\frac{4}{2}\,\mathrm{O}\,\frac{4}{1},$$

the numerator indicating the number of electrons concerned, and the denominator the number of atoms between which they are shared. This enables one to tell at a glance (1) how many external electrons there are in the compound; for example, $4 + 4 + 4 + 4 = 16$; (2) whether or not any given atom has a completed octet; for example, $\frac{4}{2}\,\mathrm{C}\,\frac{4}{2}$ means that carbon has eight electrons all shared; (3) whether an atom carries a net electrical charge; for example, the fact that the sum of the fractions $\frac{4}{2} + \frac{4}{2} = 4$ means that in this case carbon has four outer electrons as in the neutral atom. The resonance structure of carbon dioxide which Pauling writes as $^{+}\mathrm{O} = \mathrm{C} - \mathrm{O}^{-}$ appears in Niggli's formulation as

$$\frac{2}{1}\,\mathrm{O}\,\frac{6}{2}\,\mathrm{C}\,\frac{2}{2}\,\mathrm{O}\,\frac{6}{1}.$$

From this we see that the total number of electrons $(2 + 6 + 2 + 6)$ is still 16; that each atom has still a completed octet, but that while the carbon atom is electrically neutral $\left(\frac{6}{2} + \frac{2}{2} = 4\right)$ the left-hand oxygen atom carries a positive charge $\left(\frac{2}{1} + \frac{6}{2} = 5\right)$ and the right-hand one a negative charge $\left(\frac{2}{2} + \frac{6}{1} = 7\right)$.

In the development of his ideas Niggli has had the advantage of lavish facilities for the construction of models. His book is profusely illustrated with photographs of these, but the reader will probably feel that they mainly serve to emphasize the indispensability of three-dimensional aids to the study of stereochemistry.

DAVID T. GIBSON
J. M. ROBERTSON

A PSYCHOLOGIST LOOKS AT RELIGION

Personality and Religion

By Dr. William Brown. Pp. 195. (London: University of London Press, Ltd., 1946.) 9*s*. 6*d*. net.

THIS book attempts to consider the general problem of religion in the light of modern psychology. Much modern psychology, owing to a certain limitation of outlook, is in no position to give an adequate account of religion. Psychology is a natural science, and the natural sciences rightly abjure philosophy as lying outside their sphere of inquiry. But it is impossible to give a fair estimate of the validity of religion apart from philosophical inquiries. It can no doubt be examined as a section of human mental experience and activity, but as to the question of the existence of any spiritual reality with which man comes into contact in religious experience, that is a matter with which psychology is not competent to deal.

It is true that psychologists have not hesitated to pronounce upon this point. Freud's views on religion may be found in his "The Future of an Illusion". Here religious belief is dismissed as an illusion, the disguised fulfilment of a wish for security and mental comfort. In the Freudian picture the individual's environment, or the 'reality' to which he finds himself so ill adapted, is strictly limited to the outside physical and social world. The spiritual world is taken no account of and assumed not to exist.

Dr. Brown, however, is a psychologist who is also a philosopher, so that the religious problem is not, for him, so easily dismissed. Moreover, even as a

psychologist, he is doubtful of the soundness of the Freudian analysis. Its weakness is that it explains normal mental experience in terms of the abnormal, without supplying any clear criterion as to what is normal and what is not. No one would attempt to explain physiological function in terms of pathology. Furthermore, whereas pathological mental processes of projection and regression, and the influence of an Œdipus complex, are commonly diminished or eliminated by a course of psycho-analysis, this is not so in the case of religion. Dr. Brown's experience has been the exact opposite. After an analysis extending over ninety-two hours, supplemented by many hours of self-analysis later, his religious convictions were found to be stronger than before, while his religious feelings had been purified and freed from much that was merely infantile.

The Freudian theory of 'complexes' would seem to have something in common with A. F. Shand's theory of 'sentiments', which he defined as "organized systems of emotional dispositions, centred about the idea of some object". Dr. Brown would term these 'sentiments', which are normal healthy features of the mind, 'interests', and the word does give a clearer idea of what the thing is. In contrast to these sentiments or interests the complex is an abnormal, unhealthy mental system, produced in general by some painful experience in the past. It is essentially of the nature of a fixation, anchoring the mind down, whereas a sentiment is a normal, healthy growth. Through the sentiments, which grow by including within themselves a larger and larger number of objects, the mind gains greater and greater freedom and a wider scope of activity. A complex, on the other hand, ties the individual down to the incident which caused it, and the mind cannot develop. Nor is a sentiment subject to disintegration by psycho-analysis, as a complex is. Such at least is Dr. Brown's experience.

Dr. Brown suggests that the religious attitude should be considered as distinct from the logical, the æsthetic and the ethical attitudes. Religion is based on a fourth general attitude—that of the individual towards the universe "so far as he envisages it as something upon which he completely depends and to which he attaches ultimate value". So far as we value the universe, and worship it or hold it worthy, so far are we adopting a religious attitude. The man who pursues truth for its own sake and studies science in an impersonal way, with rigorous self-discipline, is really showing his belief in a religion and is taking up a religious attitude. Science may be made a religion, and in so far as it is so made, it becomes more than mere science. Philosophy too may be made a religion, but in so far as it is so made it is more than mere philosophy. Instead of regarding scientific advance as freeing us from the 'superstition' of religion, we may find that in the advance of science religion is needed more and more to restore the balance, and to keep us from reaching views which are a caricature of existence.

With regard to personality, Dr. Brown holds that it should be distinguished from individuality, which indicates a mere difference from other people. But as the individual reaches maturity he is carried towards the pursuit of values classified under the three headings, goodness, beauty and truth, which values are general, teaching us that we belong to one another, are all members of the one universe.

"We find ourselves in the universe. This is what I call personality. We see the paradoxical nature of the term. Personality is general, but it is also creative. The universality of personality is creative because it partakes of the creativeness of the totality of things."

Thus personality is to be regarded as a process rather than a product, since it is never completely produced. As it grows it produces something new, and brings with it increased insight into the nature of things and the values of the universe. Thus personality and religion are indissolubly connected.

Dr. Brown, as psychologist and philosopher, has written a book full of valuable and suggestive ideas.

J. C. HARDWICK

PRINCIPLES OF HUMAN PHYSIOLOGY

Principles of Human Physiology
Originally written by Prof. E. H. Starling. Ninth edition, by Prof. C. Lovatt Evans; the Chapters on the Special Senses, by Prof. H. Hartridge. Pp. x + 1155. (London: J. and A. Churchill, Ltd., 1945.) 36*s*.

THE first edition of Starling's "Principles of Human Physiology" appeared in 1912. It set a high standard then, and that position has been fully maintained by subsequent editions. The present one is the ninth. From time to time after its first appearance many parts have been re-written, so that now little of the original remains, though in general its plan is the same. It gives within the compass of one volume an account of the present state of physiological knowledge which will be adequate for the student of science or medicine and serve as a useful book of reference to biologists in general.

Physiology is a science that, like others, is continually expanding and it is not easy to keep a book of this kind within a reasonable size. Much credit is therefore due to Prof. Lovatt Evans, its present author, for the judgment he has exercised in his pruning and grafting. A new and welcome feature of this most recent edition is the introduction of "Historical Notes". Since the importance of any new discovery can only be properly appreciated by reference to what has gone before, it is very desirable that students should, whenever possible, have the past and present put into proper perspective. The inclusion of these summaries of the history of the subject should help to bring this about. It certainly ought to excite their interest as well as make them realize that the roots of physiology go very deeply into the past.

A chapter on the "Temperature and Heat Balance" of the body replaces the former one on "Body Temperature and its Regulation". It gives among other matters a more extensive discussion of the various physiological and physical factors which control the heat balance of the body, the effect of climate and clothing on this, and the phenomena observed when heat regulation breaks down.

In every major section of the book alterations and additions have been made to bring it up to date, in so far as that is possible in a book of this kind. When it is borne in mind that this edition was produced under the adverse conditions of war-time and, as the author states, often under actual enemy attack, all those concerned are to be congratulated on the result.

H. S. RAPER

CIVILIZATION AND THE PURSUIT OF KNOWLEDGE*

By SIR RICHARD GREGORY, Bt., F.R.S.

SINCE the annual meeting of the British Association at Dundee in the year 1939 was brought to an abrupt end by the imminence of war, it has been neither desirable nor possible to bring members together for another meeting of the usual kind in Great Britain or overseas. Even now, a year after the armistice, conditions are such that accommodation for all the sections of the British Association and their members at Newcastle or Birmingham, where, but for the War, we should have met in 1940 and 1941, is impracticable, on account of the devastation which these cities have suffered from enemy action. Next year, however, the series of annual meetings which was begun in 1831, when the Association was founded, will be resumed at Dundee, and the broken parts of the chain will again be linked together.

This year's assembly is, therefore, of a token character and is limited to a single day instead of the week usually occupied in the presentation of scientific papers and the delivery of addresses before the various sections. By the statutes of the Association it is laid down that an annual meeting shall be held, and that the president shall deliver an address at such a meeting during his year of office. For a number of reasons these two obligations could not be met during the period of the War, though I have been re-elected to the presidency every year since 1939, when this high honour was bestowed upon me.

The intervening years have, however, been very usefully employed in the preparation and presentation of reports by research committees appointed by the Council of the Association and by a number of public conferences on scientific subjects of wide interest. The conferences were organised, with the approval of the Council, by the Division for the Social and International Relations of Science, which was founded at the Cambridge meeting in 1938 with powers to arrange such meetings at times or places other than those of the normal annual meetings. Beginning with a conference on "Science and World Order", held in September 1941, and attended by representatives of more than twenty of the United Nations, a number of other conferences were arranged, the last being on "Scientific Research and Industrial Planning", held in December 1945.

All these conferences were concerned with aspects of modern science in relation to the outlook and service of contributors to the advancement of natural knowledge and their contacts with problems of progressive human development. This is the cause to which my chief thoughts and work have been devoted for the past fifty years, and for the promotion of which the British Association has always stood. As it is the custom of presidents of the Association to deal in their annual addresses with subjects which have long occupied their close attention, I cannot do better than follow the usual practice, in this swan-song of retirement, by taking as my theme "Civilization and the Pursuit of Knowledge".

* Presidential Address to the British Association for the Advancement of Science, delivered on July 20.

The Dawn of Civilized Man

The nature, origin and evolution of life, and the endeavours of man to understand it and the place in the universe of the world in which he lives and has his being, have been discussed on many occasions at meetings of the British Association. In his presidential address at the Dundee meeting in 1939, Sir Albert Seward used existing knowledge to reconstruct a view of plant life on an ancient land of which Scotland is now a remnant, and sixty million years before it was inhabited by man. Even this long period dwindles into insignificance in comparison with that of more than two thousand million years which have elapsed since the earth took geological form in the astronomical universe.

Organic life has existed upon the earth for about 1,200 million years, but *Homo sapiens* as a product of its evolution can be traced back to a stage of less than one hundred thousand years. An impressive illustration of this short period of human tenancy was given in an address by Prof. James Ritchie as president of the Section of Zoology at the Dundee meeting. Taking the twelve hours on the dial of a clock to represent the span of 1,200 million years, living organisms would cover the period from midnight to seven o'clock. From this hour until 11.15, fishes and amphibia, reptiles, birds and mammals would successively develop and predominate, with primitive man making his appearance at less than a minute before noon and our own species less than a second and a half ago. On this time-scale, the period from our Neolithic ancestors of about ten thousand years ago to the present epoch is represented by one-tenth of a second.

It is usual to date civilization from those times of the New Stone Age, when men began to cultivate food-crops, care for and breed domesticated animals, make polished flint implements, produce the potter's wheel and the plough in their simplest forms, use boats for movement on water, undertake spinning and mining, and provide by artificial means for the primary needs of communal life—food, shelter and clothing. There are still a few groups of human beings who have not advanced beyond these primitive conditions of life; but as they have not progressively improved these conditions, they cannot be said to be civilized in the sense in which the word is now understood.

What is Civilization ?

What civilization actually means depends upon the values attached to thoughts and works by which man has separated himself from his purely animal ancestry. In Johnson's time, the word was used only in a civil or legal sense and not as a measure of material, moral or intellectual attainment. Each of these elements of development can be a dominant characteristic of a human society at a particular place or period; and when they are combined to reach a high standard for the general good, the best type of social organisation may be said to have been reached.

If civilization is regarded as a formative process, then a new era began when Neolithic man became a tool-using animal, with the desire to acquire new knowledge and apply it to improve the mode of life of himself and his fellows. Its roots are in the human mind and its character is determined by the aptitude to accept ideas and give effect to them. The course of development of material resources, of morals and religion, of language and other means of emotional expression, differs in time and place, but the creative or receptive agent is always the human mind. Refinement of manners and customs is commonly associated with conventional class distinctions, but these characteristics cannot rightly be said to provide essential standards of advance in civilization. A better measure is afforded by the proportion of the community who participate in the general welfare and appreciate the opportunities provided for their physical comfort and intellectual culture.

Civilization is thus a continuous process, which for the present purpose may be said to have begun with the art of agriculture in the Near East about ten thousand years ago, and at an early date to have reached Britain with the potter's art. The first steps in the working of metals, such as gold and copper, seem, however, to have been made in the Nubian region of north-east Africa. At one time, therefore, the negroid branch of the human race could be said to have been in the van of civilization both in its art and material culture. When given opportunities for development, coloured people have proved themselves just as capable of creative thought and efficient action as the white or other groups.

It is indeed unwarrantable to assume that any group of individuals or racial types are superior to others solely because they possess greater wealth or power. There are many types of civilization, but none provides standards of highest attainment in every field of human thought and endeavour. In the past, each has had its rise and fall, sometimes because of climatic or other natural changes, but more often through the use of superior military forces and the subsequent occupation and administration of the vanquished territory. They all belong to the panorama of structures of human societies and take their separate places in the continuous record of the world's history, beginning with the advent of the New Stone Age about ten thousand years ago.

Inquiry and Interpretation

In the study of man and his activities, three types of cultural development may be recognized; and they are all measured by different standards. In the fine arts the imaginative qualities of the mind appeal primarily to the emotions through stimulation of the æsthetic judgment, with feeling rather than reason as the standard of value; material culture is the province of mechanical arts; and science—the domain of reason—is systematic and formulated knowledge in all fields of human understanding—natural, moral, social and political. Natural science, or natural philosophy, is only one division of science as thus defined; yet, by general usage, the single word now signifies organised natural knowledge. The history of civilization from this point of view is a history of intellectual development in which science has been the chief factor in changing habits of thought from superficial observation and speculative and anthropomorphic theories of causation to clear concepts, rational conclusions, and progressive principles in the advancement of man and society.

In the most primitive times man had to acquire knowledge of the world of Nature around him in order to survive. The effort to secure the food and shelter necessary for his existence demanded a never-ceasing exploitation of the resources of his environment for the progressive improvement of his material equipment—an equipment which he learned to turn against his fellow man, no less than against the animal world upon which he preyed for food and clothing, or against which he must defend himself. But in this struggle, even more than on his personal prowess, his skill, and the bringing of food-plants and animals into his service, man relied upon his imagined understanding of, and his supposed power to control, the hidden causes of the nature and behaviour of the beings and objects of his world; in other words, he believed that natural conditions and events could be modified by the medicine of magic. Though the magical beliefs of primitive man may seem to us vain and crude, they should not be despised; for in these blind gropings to probe causation in Nature may be seen the remote and humble beginnings of the urge to the understanding of the universe, which is science.

When, however, magic is understood to be the practice of the pretended art of influencing the course of natural events by compelling the agency of spiritual beings, or by bringing occult principles into operation, it is more closely related to religion than to science. Art became associated with magic and religion many thousands of years before the era of the New Stone Age, which has been taken as the beginning of civilization of human societies. Thirty thousand years or so earlier, realistic paintings and drawings were made on the walls of dark caves, and objects were carved on bone and ivory, or fashioned in clay. They still remain to afford the earliest tangible evidence of that spirit in man's nature which was to act as his guide, both for good and ill, in his upward progress towards the most advanced stages of development to which civilization has yet attained.

There are several views as to the nature of the urge which led to these manifestations of early cultural development. One is that early man, like his counterpart, the backward peoples of modern times, believed that, by the exercise of his ability to represent his desires in graphic form—in other words, to effect his purpose of controlling those forms of animal life upon which he depended for his food-supply—he was setting in motion forces more potent than his own to that end, and making of his painting and carving an act of magical invocation, or it may be of religious observance.

Even if nothing more than a magical significance be attached to these realistic representations—cave-bear, mammoth or bull, the browsing deer and the vital energy of a galloping herd of horses, and the like—certain other examples of this artistic activity afford evidence of ideas which can be placed within the category of religion, if only of a rudimentary type. Some of the figures are forms of men with heads masked as animals, such as appear in representations of gods in ancient Egypt and Babylonia. They are regarded, therefore, as evidence of early conceptions of a spirit—even of a divinity—in animal form, and are associated with worship and supplication, whether for material desires or as ceremonial connected with a cult of the dead.

Worship and Works

By Neolithic times our direct progenitors gave expression to certain clear conceptions of their belief in a form of existence after physical death and made provision for it in graves during the ritual of interment. Bodies were laid in particular positions with reference to the rising or the setting sun; and for the continued sustenance of the spirit, food was provided, with weapons for its protection, ornaments as amulets to ward off evil influences, and when human sacrifice was a part of the ritual, slaves to administer to its needs. Whatever the origin of these and other spiritual beliefs, the practice of them marks a distinct stage in the development of man's mind and works and has always played a potent part in shaping the structure of civilized life.

From one point of view, worship in the sense of adoration or reverence of the spirits of ancestors represents recognition of particular qualities of human nature and the desire to maintain them. When these qualities are conceived to be possessed supremely by supernatural beings, religion assumes a wider and more purposeful meaning. It becomes an attitude of mind towards the mysterious, with instinct as its basis and intuitive feeling as the standard of value. Religious experience can claim to be positive knowledge just as much as facts which appeal to the physical senses can be said to represent ultimate reality. As factors which have influenced human development throughout all stages of civilization, religion and science are inseparable, but it cannot be said that the two systems of thought have the same rates of rational advance, whether in principles or practice. Each is concerned with the pursuit of truth whether for its own sake or for increasing the contacts of human life with things and forces, visible and invisible, in the heavens and on the earth.

The light of truth is a spectrum of many colours to which human consciousness is receptive in varying degrees. In the physical sense, light does not become manifest until it is reflected by matter, and in the sense of a divine influence its truth has to be perceived spiritually. It is through the study of the heavens and the earth from these two points of view of worship and inquiry that religion and astronomy meet in celestial fields. All living things upon the earth depend upon the light of the sun for their origin and growth. Many millions of years before man appeared, there were song-birds which did homage to its power in pæans of thanksgiving at the passing of darkness and the coming of dawn. This form of salutation may be regarded as the beginning of instinctive reactions to the influence of light, which in man became worship and religious observance. With the recognition of the sun as a great power-station having a deity in charge came the association of light with life and goodness, and darkness with death and evil. Whether these higher abstract qualities attributed to celestial beings are reflexions of what are observed and admired in human communities or reactions to divine influence is a question which cannot be answered by positive knowledge, and must be left to individual consciousness for judgment.

Celestial Movements and Meanings

When the apparent movements of the sun and moon were used to measure intervals of time and seasons, the knowledge gained was intended for practical service and not as a contribution to rational or abstract truth. Astronomy was then the handmaid of astrology, which associated human lives and affairs with particular parts of the celestial sphere and the deities who occupied them. Astronomy is still the science of the heavenly bodies, but these are studied as physical objects and not as living beings. An immense amount of precise knowledge of celestial phenomena and events was obtained in ancient Egypt and Assyria, and its factual value is not affected by interpretations given to it. The accumulation and correlation of all such natural knowledge acquired by observation or practical experience is the function of science, while the way in which it is applied and interpreted affords a measure of the strength of a community in the history of civilization.

The association of astronomical objects and events with religious and other festivals, and with theological teaching, is a characteristic of most early civilizations, and is expressed in much of their art and literature. It is closely connected with the culture of Egypt and Mesopotamia, and also occupies a prominent place in the sacred literature of India. Among the material taken over by the Greeks from the Babylonians were the zodiac, knowledge of the planets and their courses among the constellations, and a method of predicting eclipses by means of the cycle known as the Saros—a period of eighteen years, eleven and one-third days. In this period, solar and lunar eclipses recur in a regular sequence at the same intervals of time and can, therefore, be predicted. Knowledge of the period descended to the Chaldeans, who occupied a part of Babylonia, and was transmitted by them to the Greek and Roman worlds.

When particular facts about phenomena or events reveal relationships from which no exceptions are known, they are expressed as scientific truths, and in this sense represent natural principles or laws. By discovering from the accumulation of observations during many centuries that 223 lunar months correspond with 18 years, $11\frac{1}{3}$ days, or just over 6,585 days, the Chaldeans were able to announce the 'law of eclipses' as a natural and verifiable truth. This, like the regularity of the returns of the sun and moon and unchanging groups of stars, was a striking example of law and order in Nature, whatever views were held as to its cause or purpose in the scheme of human life.

Another cycle, not to be confused with the Saros, which relates only to the prediction of eclipses, was discovered in the fifth century B.C. by a Greek mathematician, Meton. He found that there was the same number of days, within a couple of hours, in 19 solar years as in 235 lunar months. This relationship was regarded as of such importance that it was inscribed in letters of gold from 1 to 19 on Greek monuments and was called the 'Golden Number'. For more than a thousand years the Metonic Cycle has been used to determine the date of Easter, upon which all the movable feasts of Christian Churches depend. As this date is determined also by that of the spring equinox, both the sun and the moon as seen from the earth are involved in it, but by the use of the simple cycle of Meton its prediction becomes relatively easy. The point of particular interest is that astronomical observations and measurements originated the dates of the chief religious festivals from the earliest civilized times to the present day.

Reactions to influences of objects and phenomena of the heavens upon conditions of life on the earth thus connect both the physical and emotional parts of human nature. Interpretation of their causes depends upon the attitude assumed towards mysteries and the light of knowledge. Their creation and maintenance may be regarded as divine designs available for the service of mankind or as elements and forces in a universe in which the earth is but a particle. The view that celestial objects are the sources or symbols of the vital force or forces appears at the very dawn of civilization as the foundation of the great religions of the world. It was expressed in the faiths of Ancient Egypt and Assyria by impressive ceremonies in magnificent temples.

Knowledge of the constellations seems to have come to the Greeks through the Phœnicians, and was brought into practical service by its use in navigation. Homer refers to certain stars as having been sent by Zeus as portents for mariners. There are many other references to constellations in the Homeric epic poems, which describe conditions of life and thought in the period of the ninth and eighth centuries B.C. Hesiod, who succeeded Homer, gave more details of the guidance for farming operations afforded by the appearance of particular stars at different times of the year. He regarded the Iron Age, which was then beginning, as degenerate in comparison with the earlier Bronze and Stone Ages when man lived in perfect innocence in a veritable Garden of Eden. The works of both Homer and Hesiod portray stages of civilization when the affairs of deities were believed to be much the same socially as those of human beings, with little difference in their qualities or actions. Heaven and earth were thus brought together in spiritual as well as practical service, and heroes became divinities in celestial abodes.

In the Indus valley civilization the Aryans, when they invaded the country not later than the middle of the second millennium B.C., brought with them concepts which personify the forces of Nature as divine and spiritual beings. Their attitude and outlook are embodied in the hymns of the "Rigveda", which date from about 1200 B.C. and were developed in the treatises known collectively as the "Upanishads", or conferences, in about the same period as that of early Greek philosophy. The belief in the personified natural forces of the Vedas was finally carried so far as the creation of an organised polytheism or pantheon and an elaborated caste system of society in which the Brahman was supreme instead of the warrior of the Vedic classics.

Natural Knowledge and Philosophy

In this early philosophy, man is the centre of the cosmic scheme, and he shares the vital force with the gods, without being dependent upon them. He differs from all other things, animate or inanimate, in the capacity for thinking, leading eventually to the Brahmans becoming the 'head' of the social organism because they possessed it to a higher degree than other classes, including the warriors, whose powers depended upon the use of 'lower' parts of the human body. Brahmanism became a new Hinduism with the teaching that every Hindu could share this knowledge and by mystical thought attain to the same perfection. Many variations of these beliefs have been formulated and incorporated in Hinduism, but the main ideas remain the same. With the introduction of Buddhism in the sixth century B.C., came the teaching that the performance of sacrifices and daily rites to deities were no measure of attainment of the right way of human life and conduct. Since that time Hinduism and Buddhism, together and separately, have determined the course of civilization in the Middle and Far East.

It is a remarkable historical fact that the sixth century B.C. was a period of great emotional and intellectual ferment, in which there was displayed a general and widespread interest in religious and philosophic speculation, particularly in the East. Buddhism, Taoism, and Confucianism all had their origin in that century; and their followers to-day number more than half the population of the world. There is no personal god in these religions or ethical systems; but conceptions of relationships between the heavens and the earth, or the universe and man, are common components of them. Each is concerned with a way of life and the exercise of human virtues, and each is tolerant of the others. It is thus possible for the three cults, with Christianity in addition, to be accepted together as guides to individual conduct, without discrimination between them.

Though there are decided differences between the principles of Taoism and those of Confucianism, each system makes ethical conduct its chief object, and neither is associated with fanaticism against other religions. The cult of ancestor worship in China has no mythological motive, but expresses the philosophical conception that continuation of life lies not in the immortality of the soul, but in the perpetual remembrance of the righteous by mankind. The original teaching of Taoism has, however, been modified by contact with Buddhism, and Lao-tze, its founder, has become one of a trinity of deities in a mystical pantheon. While it is possible to say simply of Buddhism that it was concerned with the way of salvation of the individual, Confucianism, which is synonymous with Chinese civilization, aimed at the regeneration of a whole society through a reformation in the conduct and character of all its members.

Just as in the sixth century B.C., Buddhism, Taoism and Confucianism separated man from celestial deities, so in the same period the Greek philosophers Thales and Pythagoras began the study of Nature as made manifest to the senses with the view of discovering relationships between effects and causes. They and their Ionian school were the first 'lovers of wisdom' to separate natural philosophy from all-personifying religious faith and to constitute a method of interpreting Nature distinct from the primitive conceptions of unenlightened minds. The idea of Person in a divine sense was tacitly set aside or limited, and an impersonal Nature conceived as a separate subject of study. The scope of natural philosophy, with its objective character and invariable laws, discoverable by a proper and methodical application of the human intellect, was thus defined. Though these principles were not maintained for long, they opened up those veins of speculative philosophy which occupied afterwards so large a portion of Greek intellectual energy, with most enduring results on Western civilization.

Plato, the greatest of these thinkers, opposed the scientific school which had arisen to study natural objects and phenomena apart from supernatural agencies, and to interpret the processes involved by submitting them to independent rational inquiry. It was against these materialists, of whom Democritus of the fifth and fourth centuries B.C. was the leader and last of the physical school, that the main argu-

ments were advanced by the Socratic system of reasoning in the tenth book of Plato's "Laws". Disregard of the gods, or unbelief in their concern for human affairs and conditions affecting them, was held to be a danger to a State and a crime to be denounced by every law-abiding citizen and punished severely.

The words used by Plato near the beginning of the discourse express very clearly the difference between the scientific and theological attitudes towards the pursuit of natural knowledge; and they are to-day as truly typical of the two points of view as they were in the first recorded statement of conflict between religion and science.

"It is the novel view of our modern scientists," said Plato, "that we must hold responsible as the cause of mischief. For the result of the arguments of such people is this; that when you and I try to prove the existence of the gods by pointing to these very objects—Sun, Moon, Stars and Earth—as instances of deity and divinity, people who have been converted by these scientists will assert that these things are simply earth and stone, incapable of paying any heed to human affairs, and that these beliefs of ours are speciously tricked out with arguments to make them plausible."

This denunciation of the mode and meaning of the studies of the early Greek physicists has particular interest at the present time: for it was directed against Democritus, the renowned founder of the atomic theory. It is a tribute to the free intellectual atmosphere of Greece at the time that such an impious theory should have been conceived at all. In its crude form, the Athenian, Epicurus, used the theory as the basis of ethical teaching in which divine providence had no part; and it was expounded by Lucretius to the Roman world in his comprehensive philosophical poem "On the Nature of Things".

The Disruptive Atom

Lucretius' fervid exposition of the theory that the universe may be analysed into two elements—atoms and space—in different relationships even as an explanation of life, the mind and the soul, makes his poem a great contribution to the philosophy of science as well as to classical literature. According to this view, all forms of matter are due to combinations of unalterable atoms in ceaseless motion; and the universe is a vast concourse of them under the control of fixed laws and independent in these respects of a providence or intelligent cause continually guiding their movements.

The theory remained a philosophic speculation for about eighteen centuries before attention to it was revived; and it was established as the foundation of modern chemistry by John Dalton early in the nineteenth century. Towards the end of that century, the discovery was made that the chemical element, uranium, continuously emitted radiations which produced effects of both heat and light without measurable loss of mass. This led to the discovery of radium and other radioactive substances; and scientific attention was concentrated on all their aspects—theoretical and applied.

At the beginning of the present century these studies led to the conclusion that the energy released by radioactive action was due to the spontaneous disintegration of their constituents. In the terminology of chemistry, atoms are still the smallest units which enter into combination; and they make up the constitution of all substances, just as millions of different words are formed from letters of the alphabet. Chemical atoms are, however, now known to consist of systems of smaller particles in very rapid motion around a nucleus; and their physical disruptions become manifest in the effects of radioactivity. The source of this energy was proved later to be in the nucleus of the atom and not in the lighter particles called electrons, revolving around it. Further experiments showed that the core itself could be divided and that the process was sometimes accompanied by an enormous output of energy.

These principles of nuclear fission had been established before the discovery was made, early in the year 1939, that when the nucleus of an atom of uranium had been split in two, additional atomic bullets were produced which carried on the disintegration process by themselves. A chain reaction could thus be created which broke up the uranium with great rapidity and at the same time released energy with immense violence.

All this experimental work was done purely in the pursuit of natural knowledge, and was communicated freely to scientific societies and publications. The military significance of the fission chain reaction then came to be realized both in Europe and the United States, where, with the collaboration of American, Canadian and British scientists, a vast engineering plant was erected, and the frightful atom bomb was manufactured as an instrument of war. There were no secrets in the principles upon which its construction was based, but, as with other industrial applications of scientific discoveries, the conversion of laboratory experiments into engineering works on a vast scale meant that special methods had to be discovered and used in the process, and these alone constitute the secrets of atom bomb manufacture.

British and American scientists and technologists took three years to convert laboratory experiments into an engineering plant, that is, to bridge the gap between science and invention, and by so doing to make available an almost inexhaustible source of mechanical power. When atoms took form out of the void, this energy was locked up in their nuclear hearts; and whatever may be the spiritual meaning or purpose of its creation, the discovery of it in the pursuit of knowledge is just as natural as that of any other force. When Prometheus of classical antiquity stole fire from heaven for use on the earth, he was condemned by Zeus to daily torture for this sacrilege. The celestial fire stored up by plant cells many millions of years ago and concentrated in sediments of the earth's crust is stolen daily in the form of coal and oil and used for the service of man.

The view that to acquire such knowledge of natural properties and forces is to partake of its divinely forbidden fruits is still held and has been forcibly expressed against scientists since atom bombs were exploded with such terrible effects over Hiroshima and Nagasaki. There can never be moral sanction for such mass destruction of human life, though history affords other examples of it in crusades and similar religious conflicts. It is an offence against the light, for whatever cause it is undertaken. The pursuit of natural or of supernatural truth is the noblest of man's endeavours. The use of the knowledge gained has enabled man to penetrate into the centres of stars, but it can carry him also down into the pit to perish if his animal instincts continue to prevail over his moral understanding.

(*To be continued*)

VACCINIA HÆMAGGLUTININ

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WORK on the hæmagglutinin of vaccinia virus was initiated by an observation by Burnet in October 1941 that a chorioallantoic membrane emulsion agglutinated fowl cells to a low titre. This phenomenon was then studied by Nagler[1,2], who was responsible for the general development of the technique of dealing with the reaction. He found that not all fowls provide cells susceptible to agglutination. Roughly 50 per cent of fowls give fully agglutinable cells, another 30 per cent show varying degrees of agglutinability, whereas 10–20 per cent give cells which are quite inagglutinable. All embryonic cells are wholly inagglutinable, the character appearing in the appropriate proportion of chicks two to four weeks after hatching. Nagler showed, too, that calf lymph, despite an equally high virus content, was ineffective as an agglutinating agent.

Vaccinia hæmagglutination is inhibited by appropriate immune sera either of animal or human origin, and most of Nagler's work was concerned with the antibody response following human vaccination. In general, a significant response followed primary vaccinations or secondary vaccinations in which a fully developed vesiculopustular reaction developed at the site of inoculation.

Accelerated or immune type reactions gave much smaller rises in antihæmagglutinin titre. The antibody titre fell rapidly after reaching its peak about a month after vaccination, but in a considerable proportion of vaccinated persons a trace of residual antibody was detectable years after the last vaccination.

The next development in the work came with the recognition that ectromelia virus of mice, also in the form of chorioallantoic membrane emulsion, agglutinated the same limited range of fowl cells as were agglutinated by vaccinia virus preparations. Burnet and Boake[3] found that the two hæmagglutinins were very similar in most respects and were serologically related though not identical. The most interesting difference was that ectromelia virus preparations agglutinated mouse cells readily, while vaccinia preparations equally active against susceptible fowl or pigeon cells failed to do so. No explanation for this difference is yet available, but it is hard to believe that the susceptibility of the mouse erythrocytes is not in some way related to the virulence of ectromelia virus and not vaccinia for the species. Incidentally to this work, it was shown that vaccinia can be used to immunize mice effectively against ectromelia. Further studies of the experimental epidemiology of ectromelia, using the methods made available by these hæmagglutinin reactions, are being undertaken by Fenner.

Under the stimulus of the discovery of this relationship between vaccinia and ectromelia viruses, a further study of the nature of the hæmagglutinins was undertaken by Burnet and Stone[4]. They found it easy to demonstrate that the virus particles were not the hæmagglutinin, thus bringing to light a sharp difference from the influenza-mumps group of viruses. Absorption of vaccinia hæmagglutinin with suitable red cells leaves the virus titre unaffected: high-speed centrifugation (15,000 r.p.m. for 1 hour) deposits more than 95 per cent of virus with insignificant reduction in the hæmagglutinin titre of the supernatant fluid. In many types of experiment preparations may be obtained showing ratios of hæmagglutinin to active virus particles which are widely discrepant from those obtaining in a typical chorioallantoic preparation. The absence of hæmagglutinin in standard calf lymph of high virus content has already been mentioned. All these results are in accordance with the interpretation of the hæmagglutinin as a virus product with specific antigenic properties but considerably smaller than the virus particles.

Attempts to determine the chemical nature of the hæmagglutinin included extraction of dried material with alcohol and other solvents. It was planned to use both 'susceptible' and 'insusceptible' fowl cells in testing all fractions on the assumption that only the virus hæmagglutinin would show such a differential effect. A suspension of the alcoholic extract in saline, however, gave such a high titre agglutination with 'susceptible' cells (and none with 'insusceptible' ones) that doubts immediately arose. Suitable tests showed that any alcoholic extract of dried tissue gave a similar differential agglutination of fowl cells—stock Wassermann or Kahn antigens show the phenomenon excellently. As offering an indirect approach to the nature of the virus hæmagglutinin, Stone and Holden undertook to determine the nature of the tissue lipids responsible for this type of hæmagglutination. After an extensive investigation, Stone[5] concluded that purified lecithin (egg yolk or ox heart) dispersed with cholesterol in saline was the most active available agent, but that almost as active preparations could be obtained with cardiolipin[6], sphingomyelin and various cephalin fractions. Freshly prepared cephalin made by Folch's method[7] was almost inactive but became highly active after a few weeks exposure to the air. Cholesterol alone and various fatty acids with or without cholesterol were inactive.

These results indicated strongly that the vaccinia and ectromelia hæmagglutinins were composed of a virus antigen plus a phospholipid component, the latter being responsible for union with the surface of the cell.

So far, direct attempts to isolate the virus hæmagglutinin have been limited to showing that it may be freed from a good deal of inert material by precipitation with ammonium sulphate.

The existence of phospholipid as the effector component of the virus hæmagglutinin has, however, been demonstrated by showing that the agglutinating activity is destroyed by lecithinase of two types. Solutions of *Cl. welchii* toxin Type A prepared from dried material precipitated by ammonium sulphate, kindly given to us by Dr. A. W. Turner, rapidly destroyed the agglutinin in the presence of calcium ions but were inactive if phosphate or citrate was present in the system. Boiled material was inactive. Cobra venom 1 : 10,000 of dried material in phosphate buffer (pH 7·0) was also highly active in destroying the activity of vaccinia and ectromelia hæmagglutinins, all activity being lost in two hours at 37°.

In addition to the two different types of lecithinase known to be responsible for the major biological activities of these natural poisons, both contain other enzymes, including hyaluronidase. The hæmagglutinins are, however, stable in the extracts of chick embryo tissues or mouse liver in which they are normally prepared, and were unaffected by exposure to rat testis extract rich in hyaluronidase. Hæmagglutination by influenza viruses is quite unaffected by either *Cl. welchii* toxin or cobra venom. The

results therefore indicate that the destruction of hæmagglutinin activity is a direct function of the specific lecithinases.

Conclusion. Vaccinia and ectromelia viruses produce in infected tissues soluble hæmagglutinins active against a limited range of red cell types. The hæmagglutinins are complexes of a phospholipid (probably lecithin) with an antigenically specific virus constituent.

This is a record of work in which W. C. Boake, F. M. Burnet, E. Clark, H. F. Holden, F. P. O. Nagler and J. D. Stone of this Institute have at various times been concerned.

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HEAT DAMAGE IN CEREAL SEEDS

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RECENT work by Peters[1] and his co-workers upon burn damage in animal tissue reveals features of primary damage not unlike some present in grain which has been damaged by excessive heat during drying. This damage in grain is manifested by delay and by reduced resistance to adverse conditions when it is afterwards germinated. Animal tissue burns are complicated by diffusion from the cells of substances which may be of a toxic character, but with grain such effects appear to be absent.

As with other forms of biological damage, mild heat damage in oats, barley and wheat is reversible, but severe damage causes death of the cells. One of us[2] has shown that if grain be heated, there is a temperature of treatment at and above which the grain is incapable of germination, and also another temperature, some 9° C. lower, which causes mild damage, showing itself as a delay in the germination of the grain after planting or damping. This narrow zone of temperature separates normal grain from grain incapable of germination, and between 14 and 36 per cent moisture content (wet weight basis) the lower temperature of damage can be expressed by the equation:

$$\theta = 122 - 5 \log_{10} t - 44 \log_{10} m,$$

where θ is temperature in degrees C., t time of heating in minutes, and m percentage moisture content. At 36 per cent moisture content the equation holds at least over the range 1–120 minutes. Within this narrow zone, damage is revealed by delay in the onset of germination, and by death of some grain, the degree of damage increasing rapidly with severity of treatment. Thus the delay in appearance of germination behind a control unheated sample showing 99 per cent germination capacity* within seventy-two hours may vary from a few hours to twenty days. In the early stages of damage, using new grain of high germination energy and capacity, there is little or no effect upon the capacity of grain grown in the laboratory upon damp sand, although delay is marked. After the initial germination, growth proceeds normally, and thus damage is for all practical purposes completely reversible. After treatment at higher temperatures within the zone, many grains fail to germinate, and this damage must be considered as irreversible. A sample of wheat, and another of barley (both at 14 per cent moisture content), showed no germination capacity whatever after treatment at 74° C. (for forty minutes), but when sown after treatment at 70°, 68°, 66°...... 50° C., under normal garden conditions, they produced sound grain of high vitality at harvest, although several of the grains treated at 68° and 70° C. (especially at 70° C.) failed to germinate, and the onset of the germination of the living grain was markedly delayed.

* Germination capacity: the percentage of grain which eventually germinates. Germination energy: the percentage of grain which germinates within a specified time at a fixed temperature, for example, three days at 16° C. Good barley or wheat should show at least a 90 per cent level.

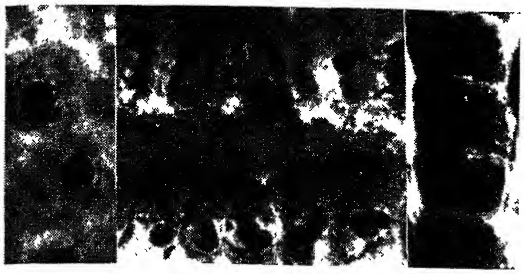
Laboratory germination tests of such heat-damaged grain had indicated that in the early stages between damping and the first visible appearance of growth, the grain, in contrast to unheated grain, was very sensitive to external conditions, especially to excess of water. Similarly a winter-sown heated wheat, showing 60 per cent germination capacity in the laboratory, was almost completely killed by winter frosts and rains within a few days of planting, while the unheated control wheat germinated normally. The evidence available indicated that heated grain needed optimum conditions of water and aeration in the primary stages, but that after growth had commenced it behaved in a normal manner.

It seemed possible that cytological examination of heat-damaged grain might reveal the nature of the reversible disorganisation effected by heat, and one of us (P. T. T.) has examined embryos of such grain, both of barley and of wheat, completely covering the damage zone at 15 per cent moisture content and thirty-six minutes heat treatment (50–76° C.).

Attention was first concentrated upon the chromosomes because Peto[3] had reported that heat treatment of dormant and germinating barley caused many chromosome breaks and translocations in the cells of the root tips of young plants. No chromosome abnormalities sufficient to account for the general delay in germination were detected in the present material. Nor was there evidence that the delay was due to later differentiation following elimination of abnormal cells. The fact that only rarely did the seedlings show growth distortion and that the mature plants were morphologically and physiologically normal would also point to a non-genetic effect of heat rather than to a permanent effect on the chromosomes. Plants from heat-treated grain were, it is true, somewhat shorter in the straw, but meiosis and pollen fertility were normal.

Other cytological observations were carried out at 4-hour intervals during the incubation of grain in contact with water at 27° C. in order to test this view. The following results were obtained.

(1) *Normal grain* showed a gradual increase in the size of the nucleolus (Fig. *a*) accompanied by a rapid decrease in the basophily of the cytoplasm (Pappenheim's stain) before the first nuclear divisions occurred. Afterwards the staining intensity remained steady at the lower level. This course of development is probably at least in part due to the transformation of the ribonucleic acid in the cytoplasm to the desoxyribose form necessary for chromosome reproduction[4].



CELLS FROM EMBRYOS OF BARLEY SHOWING DIFFERENCES IN NUCLEOLI AND STAINING INTENSITY IN NORMAL GRAIN (a), HEAT-DAMAGED GRAIN (b) AND HEAT-KILLED GRAIN (c), AFTER 24 HR. INCUBATION AT 27° C.

(2) *Heat-damaged living grain* showed at first no change in the nucleolus. The duration of this quiescent period depended on the severity of the heat treatment. Then activity as in normal grain occurred, but as the nucleolus increased in size it yielded blister-like protrusions (Fig. *b*). This activity was accompanied by a slower decrease in the basophily of the cytoplasm. When serious blister formation occurs, the damage is apparently irreversible.

(3) In heat-killed grain there was no change in nucleolar size; the basophily of the cytoplasm showed no decrease and may even have increased slightly (Fig. *c*).

The observations on the nucleolus suggest that, even when still alive, the damaged cell has lost some of its power of selective permeability. It is unable when active to control the entry of water into the nucleolus. Support for this suggestion is obtained from the fact that when water uptake is restricted, the abnormal nucleolar behaviour in damaged grain is much less marked, and the grains eventually germinate. Nevertheless, before germination damaged grain still shows the lag in development of the nucleolus. The rate of decrease in basophily of the cytoplasm to the level at germination, and later, is similarly slower. The sensitivity of damaged grain to excess water and to the formation of nucleolar protrusions thus seems to be secondary and due to alterations in permeability.

The primary factor in heat damage seems to be an inactivation of the cell, accompanied by an alteration in permeability which may be of much less importance. As the chemical activity of the cell is believed to be essentially enzymic in character, such inactivation suggests at least one vital heat-labile system in the earliest stages of the chain of activity preceding cell division, and such a bottleneck may be responsible for the delay in germination. This delay may well be due to inactivation of enzymes responsible for reduction of ribose nucleic to desoxyribose nucleic acid. The changes in staining intensity would agree with such an interpretation.

Measurements of carbon dioxide output of respiring grain[5] indicated that the respiration of mildly damaged grain was almost normal, and even of severely damaged grain was much greater than corresponded to its final germination capacity. Thus such figures were quite useless as tests for mild heat damage, and even grain incapable of germination showed a carbon dioxide production one fifth or so of that of normal grain (at 30 per cent moisture content). The respiration death point (that is, where respiration was but 1–2 per cent of normal) was some 4° C. above the germination death point. It thus seems that mild heat damage is not accompanied by, and could not be attributed to, inactivation of enzymes primarily concerned with the respiration process. Similarly with animal tissue Peters reports that after heat treatment at the marginal damage temperatures, tissue respiration showed no fall.

Quoting Peters' report: "50–55° C. for 30–60 seconds is a critical temperature for damage, producing permeability changes with liberation of substances from the skin cells, which can be detected histologically. The degree of damage has been correlated with increasing temperature. Higher temperatures induce a different condition, including fixation and coagulation of the protein; the actual temperature for damage is 48–50° C. This temperature can destroy some enzymes in a short period; but it is not yet decided whether enzyme damage or change in lipoprotein in the cell interface is the initial biochemical alteration."

Dry wheat at 14 per cent moisture content is not strictly comparable with living tissue, because of the influence of water content upon temperatures of damage, but grain at 37 per cent moisture content, as just prior to germination, if immersed in hot water for one minute, shows a damage zone of 53–62° C. (water temperatures). The results of Hutchinson and Booth[6] indicate that at the death temperatures of the wheat grain there is severe protein coagulation and enzyme inactivation, and that in damp grain treated at the low temperature of damage which causes but little delay in germination, alterations can be detected in the grain which are almost certainly due either to a form of protein coagulation or to enzyme inactivation. Careful observation reveals some slight germination delay at temperatures a few degrees below 53° C., and indicates too that vitality as judged by ability to withstand excess water and other sub-optimal germination conditions is probably adversely affected. It may thus be that in the case of grain, as with animal tissue, the first biochemical alteration is a permeability change, whereas the retardation of germination is probably caused by enzyme inactivation at slightly higher temperatures.

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DIELECTRICS IN THEORY AND APPLICATION

TWO discussions on the subject of dielectrics were held recently, the first by the London branches of the Royal Institute of Chemistry and the Institute of Physics jointly at the Royal Institution on March 20, the second by the Faraday Society during April 24–26 at the Wills Physical Institute at Bristol. The former meeting surveyed broadly the fields of physical theory, chemical preparation and industrial application of the subject, while the latter discussed surveys and original papers on the present state and immediate trends of physical-chemical and physical research.

Dealing first with the more 'industrial' side, N. J. L. Megson, adviser on plastics to the Ministry of Supply, showed that the most important new dielectrics are

usually of the high-polymer type. Most of the latter are either 'thermoplastic' (plastic when hot) materials with long chains having considerable freedom of movement, or 'thermosetting' (hardened by heat) materials which when heated yield a cross-linked structure with little freedom. Either type may be produced by condensation or polymerization. The general type of electrical properties can be predicted from the chemical structure; for example, the improvement from the 'Novolak' phenol-formaldehyde to the cresol- or xylenol-formaldehyde and thence to the benzyl resins may be ascribed to the relative increase of hydrocarbon and decrease of polar hydroxyl groups. The polar amino structure of urea and similar resins gives electrical properties no better than those of phenolic resins; but the high nitrogen content may be the reason why they are less subject to 'tracking'. Polymerized hydrocarbons such as polythene and polystyrene are excellent dielectrics, but are softer and less resistant to heat due to the absence of cross-linkages. Some increased resistance to heat has been achieved by substituting chlorine for hydrogen in polystyrene. Another recent method of inducing heat resistance is by the polymerization of doubly unsaturated compounds, such as the diallyl derivatives, from which resins are obtained resembling the methyl-methacrylate resins but having thermosetting characteristics. Lastly, there is the substitution of carbon by silicon obtained in the 'silicones', which are based on the —O—Si—O—Si— chain and can be cross-linked. Although these last are highly resistant to heat, and the other methods have also shown promise, the plastic, which is an excellent dielectric, resistant to heat and easily utilizable, is not yet in production.

A. J. Maddock dealt with dielectric heating where the materials involved, such as glues, wood and fabric, are not always regarded as dielectrics. Heating by dielectric losses in a high-frequency field has the advantages that the heat is generated uniformly throughout the volume where it is wanted, and the low thermal inertia permits rapid heating and close control. Frequency is not critical, since the total energy loss as the frequency passes through that of a dipolar absorption shows no maximum and the losses in practice change only slowly. While the idea was suggested by von Siemens and Tesla, it was not until 1935 that Leduc applied the method to vulcanizing rubber, while the major development has been confined to the past few years. In the range 2–5 Mc./s., powers up to hundreds of kilowatts are used; from 10 to 25 Mc./s. medium powers apply with instances up to 100 kW.; from 50 to 80 Mc./s. the power does not usually exceed 1 kW.; while in the range 100–200 Mc./s. only low-power special applications are involved.

A very successful application is the preheating of plastic materials prior to moulding and the polymerization of thermosetting resins used to bond paper, fabric and wood into boards or articles such as gear wheels. In bending plywood in two directions the material can be built up over the former by lightly 'tacking' it with a species of 'gun': the assembly is then compressed and heated in its final shape, since the 'tacks' can then break. The gun is formed of a coaxial transmission line, the open end of which is pressed on to the work, by which the high-frequency field is applied locally in the vicinity of the end. The combination of this analogue of spot-welding with shaped electrodes for seams enables plastic, bonded and glued articles to be made by rapid and continuous processes usually associated with more amenable materials such as fabrics without the damage involved in operations such as stitching. Dielectric heating may be used for drying provided the rate of extraction of moisture is not a limiting factor; an example is in drying artificial silk. Possibilities being explored lie in reheating cooked foods, softening frozen foods and the sterilization of poor thermal conductors.

The present state of the physical theory of solid dielectrics was surveyed by S. Whitehead, director of the British Electrical and Allied Industries Research Association, at the London meeting, and by H. Fröhlich (to whom recent theoretical developments are largely due) at the Bristol meeting in rather similar terms. The absorption bands or natural frequencies of small molecules lie in the visible or near infra-red; but with large molecules, such as are encountered in dielectrics, the absorption bands can be of much lower frequency. These collision-broadened bands can influence the electromagnetic spectrum, for example, at 10^{10} cycles per sec., because Van Vleck and Weisskopf and also Fröhlich have shown the classical Lorentz theory to give too small an effect at frequencies remote from the natural frequency. The normal electromagnetic range is influenced by dipoles which, in many solids as opposed to liquids, may only have one direction with respect to the molecular axis, but of either sense in that direction. When the dipolar interaction is small, as in dilute solutions or at high temperatures, the transition of the dipoles from one direction to the opposite provides a relaxation time and a resultant variation of dielectric constant and loss angle very similar in shape to that derived from the Debye theory, except for the values and significance of the parameters. When most of the molecules are dipolar so that their interaction is important, and when the temperatures are low, the turning of some dipoles may facilitate the turning of others in the vicinity, leading to an effect analogous to the 'domain' hypothesis in ferro-magnetism.

The transition from the low-temperature to the high-temperature case occurs at a critical temperature which may be the melting point, and is of the type known as a λ-transition, where the dielectric constant can reach very high values and where there is a discontinuity in the specific heat, in conformity with the work of Müller and Ubbelohde. In the high-temperature or dilute-dipole region, it seems that the right shape of dielectric constant and loss-angle curves is probably only found with ice, so that with this exception supplementary hypotheses such as those of Yager and of Garton of a distribution of relaxation times are required to explain experimental results on solids. Lamb confirmed at Bristol the behaviour of ice except that a large power-factor at 10^{10} cycles per sec. requires an additional source of absorption; while a paper by Smyth, in essence, approached some of the foregoing hypotheses from the aspect of molecular freedom.

Some detailed discussion centred around the theory of the internal field in dielectrics. Debye, Onsager and Fröhlich all regard the dielectric as a continuum with respect to a dipole; by the first, the medium is supposed to react slowly to change of dipole orientation; Onsager thinks the medium reacts quickly compared with the dipole; while Fröhlich takes into account the relative magnitudes of the relaxation times of dipole and medium, indicating that Onsager should be right at high

temperatures. Actually, however, the vicinity of a dipole has a 'discrete' structure, and Sack has calculated the exact effect of short-range interaction for a single-dimensional case of a chain molecule, showing that the frequency dependence according to Debye or Fröhlich is unaltered. Baur and Massignon put forward a calculation of the interaction potential in a crystalline field, or rather a general method of calculation. Frank concluded in general that Debye's 'hindering energy' has real significance and that Onsager must always be to some extent in error, while he also gave an analysis of certain detailed types of interaction. Kirkwood and also Böttcher considered the internal field in an amorphous fluid; the former gave an exact theory for the sphere of influence around a dipole considered as fixed.

Dipole relaxation is generally associated with a species of viscosity in liquids, but in solids is held to be a thermally activated transition across a potential barrier; although Pelzer directed attention to Kramer's view that a kind of diffusion analogous to Brownian motion forms a more general concept to which the activation process is an approximation. But the differences discussed between experiment and existing theory may well have been greater than possible errors on this account. Fröhlich has explained that the relaxation time in a chain molecule should increase at first proportionately with chain-length but thereafter more slowly with an asymptotic curve. The papers by Willis Jackson and Powles on benzene and paraffin solutions, Collie, Ritson and Hasted on water, Abadie on acetone and water, Whiffen and Thompson on pure hydrocarbons, related materials and solutions, supported the general outline of fairly well-defined relaxation times, but no simple concept of viscosity can be applied. Nevertheless, particular interest is attached to the first paper, because it is believed that the experiments on benzene solutions are the first to show a good agreement with Debye's theory with a single relaxation time, due possibly to the small molecules involved.

Girard and Abadie indicated the wide deviations from theory which are observed in some cases, and mentioned the complexity introduced if the liquid molecules were conceived as ellipsoidal instead of spherical; Schallamach has studied the properties of mixtures of dipolar liquids and the multiple absorption bands which can occur. As to solids, Oakes and Richards in the case of chlorinated polythenes, Plessner and Richards in the case of solutions of esters in polyisobutylene and polythene, Carter and others in the case of natural and synthetic rubbers, have applied with some success the hypothesis of Fuoss and Kirkwood, which is essentially similar to Garton's earlier theory already mentioned of a distribution of relaxation times. However, Garton and also Gevers and du Pré addressed themselves to the problem of good dielectrics with small power factors which vary only slightly with frequency over wide ranges. Both papers adopted the Pelzer–Wigner transition-rate method with a distribution of heights of the potential barriers. Garton considers the transition from permanent 'potential wells' or equilibria to temporary 'wells', the depth or binding energy of which have a Maxwellian distribution, whence the relative constancy of the power factor follows. Gevers and du Pré, however, only go so far as to indicate the general kind of distribution of potential barriers which can explain observation, ignoring Garton's point that the polarizability depends on the relative life of a dipole in a given state.

This modification of the rate process stimulated discussion, as also did the attempts to identify the potential barriers by Eyring's method with activation energies and entropy changes associated with physical-chemical bonds, particularly when, as in Whiffen and Thompson's work, the entropy change of activation appeared negative. It was shown that this anomaly is entirely dependent on the multiplying factor in Eyring's equation which, so to speak, sets the time-scale, so that it is difficult, if not impossible, to make an absolute interpretation on these lines in absence of an exact solution of the particular solid structure, although relative changes should be valid. A relative change is involved, for example, in the comparison of homologues with different chain-lengths, where Fröhlich's views seemed qualitatively to be confirmed. Lastly, Whitehead directed attention to the use of linear theory in analysing dielectric properties, such as eliminating undesirable or inaccurate parameters, and the difficulty attending experimental verification unless the crucial range can be properly chosen.

Perovskite crystal types which include the high dielectric constant titanates formed the subject of two papers. The structure is that of connected octahedra as regards the oxygen atoms, or cubic as regards the titanium (or similar element) atoms, with a central large metallic cation. According to Miss Megaw, if the latter is too small for stability, the cubic symmetry may be distorted to monoclinic form; but in some compounds, including those with high dielectric constants, the metallic cation is too large and there is tetragonal distortion with a λ transition to the cubic form above a critical temperature, with possibly another reverse λ transition at a lower temperature analogous to the double transition in piezoelectric crystals. Rushman and Strivens, adopting this picture, considered the possibility of the small titanium ion's 'rattling' in the structure distorted in the tetragonal manner, so that an effective dipole is produced. They claimed that the general behaviour of these crystals could thus be explained, and the high dielectric constant would be an example of the λ transition and an analogue to the ferro-magnetism discussed by Fröhlich. However, the highest dielectric constant does not actually occur at the temperature for the crystalline transition, and in the discussion doubt was cast on the hypothesis that the polarization was due to the type of ion displacement described.

A notable feature of the papers at Bristol was the enormous advance made during the War in high-frequency dielectric measurements in the centimetric wave-lengths, up to $2 \cdot 5 \times 10^{10}$ c./s. The infra-red region is not very remote from this, and some discussion took place on the use by Whiffen and Thompson of what is essentially an infra-red technique adapted to these frequencies. Willis Jackson summarized the main features of resonance and standing-wave methods applied particularly to coaxial lines and wave guides; he gave the basic relations between complex dielectric constant, refractive index, power factor, permittivity, propagation constant, attenuation coefficient and phase constant, indicating the way in which these various but equivalent parameters appear in different methods of measurement and description.

At the London meeting, Megson, and at Bristol, Sutton, indicated the many ways in which dielectric studies have elaborated or given concrete expression to chemical concepts. The importance in engineering

is daily self-evident. The theoretical physicist using the dielectric approach has probably made a more remarkable contribution to the theory of the solid state and, to a less extent, the liquid state; but his fertility has rather overwhelmed the experimentalist. The rich and varied experimental techniques disclosed at these meetings give, however, high promise for the eventual elucidation of these difficult but fundamental problems.

OBITUARY

Sir George Julius

When the Australian Council for Scientific and Industrial Research was established in 1926, Sir (then Mr.) George Julius was invited to take the part-time chairmanship of the Council and of its Executive Committee. He held office until the end of 1945, and so was intimately associated with all the developments of this virile organisation during its first twenty years. He died on June 28 at the age of seventy-three.

Born in Norwich, Julius was educated at the Church of England Grammar School in Melbourne and later at the University of New Zealand, where he attended classes with his contemporary and friend, Ernest Rutherford. Graduating in engineering, he was appointed in 1896 to a post in the Locomotive Department of the Western Australian Railways, and while there he carried out an extensive investigation of the mechanical properties of Australian hardwoods. After eleven years he left Government service and set up as a consulting engineer in Sydney. His firm (later Julius, Poole and Gibson) was in the course of years associated with very many of the main engineering enterprises of Australia.

Sir George's personal contacts were wide, but his chief interest lay always in mechanical invention, much of his work being done in a very fine private workshop at his beautiful home at Darling Point on the edge of Sydney Harbour. He is perhaps best known to most people for his work on the Julius totalizator, now in use on many racecourses throughout the world. His father, the late Churchill Julius, formerly Archbishop and Primate of New Zealand, and himself no mean amateur engineer, was always deeply interested in his son's inventions, including all improvements to the totalizator; but he was careful to preface an approach to the subject by a declaration that such machines might well be sunk in the Harbour!

In 1898 Julius married Eva, the third daughter of another very famous Australian engineer, Mr. C. Y. O'Connor, who built the Mundaring Weir at Perth and, despite deplorable political interference, carried through to complete success a scheme for the transmission of water from Mundaring to the goldfields of Kalgoorlie and Coolgardie.

As president of such bodies as the Australian Institution of Engineers, the Engineering Association of New South Wales, and the Electrical Association of New South Wales, Sir George played a notable part in the professional public life of his adopted country. He was knighted in 1929 and later received the honorary degree of D.Sc. from the University of New Zealand. His last visit to England was in 1927, when he attended the Empire Agricultural Conference which led to the establishment of the Imperial Agricultural Bureaux.

David Rivett

NEWS and VIEWS

New President of the British Association: Sir Henry Dale, O.M., G.B.E., F.R.S.

Sir Henry Dale has been elected president for the year 1947 of the British Association for the Advancement of Science. Sir Henry was formerly director of the National Institute for Medical Research, and for ten years before that he directed the Wellcome Physiological Research Laboratories (1904–14). He has achieved world recognition for his work on the physiological effects of histamine, a derivative of ergot, which was followed by brilliant researches resulting in the isolation of histamine and acetylcholine from animal tissues. Later work was devoted to examining the part played by these substances in physiological and pathological processes. Many other research workers have carried out their investigations under Sir Henry's guidance.

But apart from his own scientific research work, Sir Henry Dale has taken a very active part in the organisation of scientific work in Great Britain. For ten years (1925–35) he was one of the secretaries of the Royal Society of London and in 1940 was elected president of the Society—an office which he filled with conspicuous success until his statutory resignation in 1940. Until September of this year he is director of the laboratories and Fullerian professor of the Royal Institution—a post he has held since 1942. He is also a member of the Medical Research Council. He is a foreign member of numerous learned societies throughout the world. It is clear that in view of Sir Henry's outstanding career both as a scientific research worker and as administrator and organiser, the Council of the British Association has made an eminently wise choice for its next president.

Botany at the Fouad I University, Cairo: Prof. F. J. Lewis

Prof. F. J. Lewis has recently retired from the chair of botany in the Fouad I University, Cairo, which he has held since 1935. A graduate of the University of Liverpool, he devoted himself to ecological investigations and published a number of important papers on the post-glacial beds of the peat mosses of the north of England and also of Scotland. He gave up his lectureship in Liverpool to become professor in the newly founded university of Alberta, where he continued his ecological work, relating it to the rigorous climatic conditions of Canada. It must have been a great change for him to settle in Egypt; but new opportunities for ecological investigations presented themselves and led him to the establishment of a desert laboratory some little distance from Cairo. Very different problems also presented themselves by the accumula-

tion of weeds blocking the canals and drains of the Nile Delta. With the help of two of his assistants, he undertook to investigate for the Ministry of Public Works this serious interference with the system of irrigation.

As a teacher and organiser of research Lewis was most successful, as can be gathered from the rapid growth of his Department and from the fact that many of his students stayed on to prepare for the M.Sc. and Ph.D. degrees by research. During the earlier years of his stay in Egypt, the Faculty of Science was housed in an old palace at Abbassia between Cairo and Heliopolis, but for his growing department a new and more spacious laboratory was planned at Giza, the main site of the University (*Nature*, July 13, p. 43). With infinite tact and patience Lewis overcame all the difficulties this proposal involved and he now leaves the Botanical Department adequately housed for the accommodation of about 1,200 students and the large staff of lecturers and demonstrators. Fortunately, during the last few years Lewis has had the help of another professor, Prof. Y. S. Sabet, who has been a most loyal colleague. With both his students and his staff Lewis has been deservedly popular. Thus Prof. Lewis can now look back on his ten years of hard work in Cairo with complete, as well as pleasurable, satisfaction, and perhaps that has enabled him, in spite of a trying climate and war-time conditions, to retain abundant physical and mental energy.

Botany at University College of Science, Calcutta
Prof. S. P. Agharkar

PROF. SHANKAR PURUSOTTAM AGHARKAR, of the University College of Science, Calcutta, has retired after thirty-two years of service. Prof. Agharkar was appointed Ghose professor of botany in 1914 and deputed to Germany for further studies. In Berlin he studied under A. Engler, L. Diels, G. Haberlandt and others and obtained the doctorate of the University in 1919. In the meantime, with the inauguration of the Post-Graduate Department of the University of Calcutta, the palatial residential building of the late Sir Tarak Nath Palit at Ballygunge was converted into the Biological Laboratory and Prof. Paul Brühl was placed in charge of the Botany Department. He equipped it on a large scale in different branches of botany and initiated research work by students at the University. Prof. Agharkar returned to the University in 1920. In 1929 he took complete charge of the Department after the retirement of Prof. Brühl. From then onwards, Agharkar succeeded in increasing the number of members of the teaching staff for the different branches of botany, so that to-day facilities for research in mycology, cytogenetics, physiology and palæobotany, etc., are available in the laboratory, and much good work has been published.

Throughout his career, Prof. Agharkar has played a prominent part in the different scientific societies of India: he presided over the Botany Section of the Indian Science Congress in 1924; he was president of the Indian Botanical Society in 1934; hon. secretary of the Indian Society of Soil Science (1935–40); president of the Botanical Society of Bengal (1939–42); president of the Indian Ecological Society (1944–46); biological secretary of the Royal Asiatic Society of Bengal (1943–44). He has been a member of the Committees of the Imperial Council of Agricultural Research since 1930, of the Indian Central Jute Committee since its establishment, of the governing body of the Indian Research Fund Association 1939–42. He played a prominent part in organising the scientific activities of the two well-known All India scientific organisations, namely, the Indian Science Congress Association as its general secretary from 1924 until 1934 and the National Institute of Sciences of India as its honorary secretary during 1935–45.

Prof. P. C. Sarbadhikari

PROF. P. C. SARBADHIKARI, who succeeds Prof. Agharkar in the Ghose professorship of botany at the University College of Science, Calcutta, is a former pupil of the late Sir John Bretland Farmer, at the Imperial College of Science and Technology, London, where he obtained the degree of D.Sc. in the University of London and won distinction as a research student. His original work has been mainly cytological, and in this field he has made notable contributions to our knowledge of the life-histories of fungi, ferns and flowering plants. Both as a student and while on leave as a teacher at Colombo he made wide contacts, by working at the Royal Botanic Gardens, Kew, at the John Innes Horticultural Institution during the time of Bateson, at the Jodrell Laboratory with Miss Digby, and in Paris where he worked under Guillermond. For many years associated with the University of Ceylon, first as a lecturer and later as professor of botany, Sarbadhikari returns with a long and varied experience to the University of Calcutta where he had first graduated a quarter of a century ago.

Civil Engineering at King's College, London: Prof. A. D. Ross

DR. A. D. ROSS, who will succeed Prof. C. H. Lobban in the University of London chair of civil engineering at King's College (see *Nature*, July 20, p. 91), graduated at Edinburgh in 1929. After some years in professional civil engineering on railway and road construction, he returned to the University of Edinburgh as an assistant in the Engineering Department under the late Sir. T. Hudson Beare. He left Edinburgh to serve for a time as an education officer with the Air Ministry, and since 1935 he has held the appointment of lecturer in the Department of Civil and Mechanical Engineering at King's College, London. Dr. Ross's main interest has been in the field of concrete and reinforced concrete, and he has studied especially the non-elastic deformations in this material and their effects on the stress distribution in structures. His earlier work was concerned with an analysis of the numerous factors controlling creep, and he has devoted attention to the influence of the ratio of surface area to volume on the magnitude and distribution of shrinkage. Subsequent work has been concerned with the application of the knowledge of creep and shrinkage to reinforced concrete structures, and he has obtained solutions to a variety of problems in the distribution of stress by means of an idealized Voigt model. The results of his researches have been communicated in papers published by the Institution of Civil Engineers and other technical bodies.

International Federation of University Women

THE International Federation of University Women is holding its twenty-sixth Council meeting—the first since the War—at Crosby Hall, Chelsea, by

invitation of the British Federation of University Women, during July 27–August 1. Crosby Hall, which was requisitioned during the War, is re-opening as an international hall of residence and club for university women on August 6, immediately after the Council meeting. A large number of countries will be represented at the Council, including the Argentine, Australia, Belgium, Brazil, Denmark, Finland, France, India, Ireland, Luxemburg, the Netherlands, Norway, Palestine, Poland, Sweden, Switzerland and the United States. At a discussion meeting: "Bridging the Gap—1940 to 1945" on Sunday, July 28, three speakers will describe the experiences of university women during the War in the occupied, non-occupied and neutral countries respectively; and on July 30, Prof. Lise Meitner will give a public lecture on "Atoms and Atomic Energy" at Chatham House. The International Federation of University Women, which was founded in 1919 to promote understanding and friendship between university women of different nationalities, and thus to develop co-operation between their countries, had in 1939 a membership through its affiliated associations of nearly 80,000; there has been a considerable growth in membership during the war years, the estimated total being now about 94,000. The greatest proportionate increase has been recorded in the associations of the liberated countries. Since the liberation, several schemes have been launched by different national associations, including the British Federation, to help university women in the liberated countries to recuperate after the strain of enemy occupation, and to resume their professional careers and intellectual life.

D.D.T.

1.1-*bis*-(4 chlorophenyl)-2.2.2.-trichloroethane, produced in Switzerland in the early years of the War, was the first synthetic contact insecticide which could rival in efficiency and cost the vegetable products pyrethrum and derris. Information about it reached Great Britain and the United States at a time when the world shortage of pyrethrum, combined with increasing demands from the armies of the United Nations, was causing great anxiety among those responsible for military hygiene. On both sides of the Atlantic official committees of experts were convened to advise and to co-ordinate research. In Great Britain most of these activities were centred in the Insecticides Development Panel of the Ministry of Production under the chairmanship of Sir Ian Heilbron. The work of these committees largely resolved itself into the development of applications of D.D.T. for the special purposes of controlling mosquitoes, flies, lice and other insects of military importance. The results of investigations and trials were circulated in numerous reports produced in Britain, the Dominions and the United States, and freely interchanged. Many of the reports were at the time marked 'Secret' or 'Confidential' and the information appearing in the popular press was apt to be highly coloured or inaccurate. Some of these reports have since been published; but the main results, both published and unpublished, have now been brought together in the form of a pamphlet issued by the Ministry of Supply, entitled "Some Properties and Applications of D.D.T." (London: H.M. Stationery Office. 6*d*. net). This pamphlet includes a brief summary of some of the agricultural and horticultural uses of D.D.T.

Research on Rodent Control

THE Department of Animal Health of the University College of Wales, Aberystwyth, has accepted the offer of the Universities Federation for Animal Welfare to endow a research studentship for work in rodent ecology, the object of such work being the search for humane and efficient methods of controlling rodent populations; and Miss Winifred Maisie Phillips will be the first holder of the studentship. The grant (£180 for the research student and up to £170 for travelling and subsistence expenses) has been made for one year in the first instance, but it is understood that the Federation is prepared to continue the support for up to three years should the results justify this. It is anticipated that the greater part of the field experimentation will be carried out on territory covered by the West Wales Field Society, to which the Federation has made an initial grant of £150 for the current year. The programme of work now envisaged falls into three parts: (*a*) A survey of the mammalian fauna of the islands visited by the West Wales Field Society and of selected mainland territory. The survey of the islands was suggested by Mr. Charles Elton and the estimates made should form the basis of future studies upon the effects of certain treatments. (*b*) Research on humane poisons for rats. This work follows from the Conference held at Oxford on May 10, 1945, between members of the staff of the Bureau of Animal Population and nominees of the Federation. (*c*) The control of rabbits with special reference to surface-dwelling rabbits in woodlands. Preliminary ecological work upon the rabbit was carried out before the War at the Bureau of Animal Population, Oxford, by Mr. H. N. Southern, with the aid of a grant from the Federation. The special study of surface-dwelling rabbits in woodlands was also suggested by Mr. Elton, and it is expected that suitable territory for investigation will be found on farms operated by, or associated with, the Department of Animal Health of University College, Aberystwyth.

The Carlsberg Laboratory

WE are pleased to announce the resumption of the receipt of the *Comptes Rendus* of the Carlsberg Laboratory, published in Copenhagen. The Chemical Section, covering the period 1940–45, comprises twenty-eight parts, and it is not possible to summarize such a large amount of material. It is hoped, however, to deal with some of the papers in due course. The following may be mentioned: K. Linderstrøm-Lang and C. F. Jacobsen on the number of peptide bonds in insulin (23, No. 13), and on the properties of 2-methyl-thiazoline and their relation to the protein problem (23, No. 20); A. Søeborg Ohlsen on the histochemistry of the stomach (23, No. 21); A. Grönwall on the solubility of lactoglobulin (24, Nos. 8–11); K. Linderstrøm-Lang on solutions of diffusion equations (24, No. 13); H. Holter and K. Linderstrøm-Lang on the theory of the Cartesian diver (24, Nos. 17–18) and E. Zeuthen on a Cartesian diver micro-respirometer (24, No. 19).

Commonwealth Fund Fellowships Awards

The Fellowships offered by the Commonwealth Fund of New York to British graduates for tenure in American universities have now been resumed after interruption by the War, and the Committee of Award has made the following appointments for

1946–47: Dr. Ronald Bentley, Imperial College of Science and Technology, University of London, to Columbia University, in chemistry; Dr. K. L. Blaxter, University of Reading, to the University of Illinois, in agriculture; Dr. A. H. Cruickshank, University of Aberdeen, to Johns Hopkins University, in medicine; Dr. C. E. Dalgliesh, Trinity College, Cambridge, to Harvard University, in chemistry; P. V. Danckwerts, Balliol College, Oxford, to the Massachusetts Institute of Technology, in engineering; A. B. Drought, University of Liverpool, to the Massachusetts Institute of Technology, in architecture; J. W. Garmany, Rhodes University College, University of South Africa, and Queen's College, Oxford, to Princeton University, in economics; G. O. Jones, Emmanuel College, Cambridge, to the Massachusetts Institute of Technology, in engineering; J. P. Keane, University of Wales, Cardiff, and University of London, to Harvard University, in economics, political theory and public administration; Charles Kemball, Trinity College, Cambridge, to Princeton University, in chemistry; A. M. McKelvie, University of Glasgow, to the Mayo Clinic, in medicine; F. S. Miles, University of St. Andrews, to Harvard University, in political science; D. G. Northcott, St. John's College, Cambridge, to Princeton University, in mathematics; Dr. D. J. O'Connor, Birkbeck College, University of London, to the University of Chicago, in philosophy; W. M. Ogston, New College, Oxford, to the California Institute of Technology, in engineering; D. J. Price, University of London, to the University of Pittsburg, in physics; J. H. Read, University of St. Andrews, and Emmanuel College, Cambridge, in cinematography; Cyril Reid, Imperial College of Science and Technology, University of London, to the University of California, in engineering; I. P. Watt, St. John's College, Cambridge, to the University of California, in English literature; D. H. Whiffen, St. John's College, Oxford, to Cornell University, in chemistry.

The Night Sky in August

Full moon occurs on August 12d. 22h. 26m. U.T. and new moon on August 26d. 21h. 07m. The following conjunctions with the moon take place: Aug. 3d. 01h., Jupiter 4° S.; Aug. 24d. 16h., Saturn 3° S.; Aug. 25d. 11h., Mercury 4° S.; Aug. 29d. 18h., Mars 5° S.; Aug. 30d. 11h., Venus 6° S.; Aug. 30d. 18h., Jupiter 3° S. In addition to these conjunctions with the moon, the following conjunctions occur: Aug. 9d. 14h., Venus in conjunction with Mars, Venus 0·6° S.; Aug. 31d. 00h., Venus in conjunction with Spica, Venus 0·2° N. Occultations of stars brighter than magnitude 6 are as follows: Aug. 15d. 23h. 00·8m., 24 B. Ceti (*R*); Aug. 21d. 00h. 10·7m., 129 H^1 Taur. (*R*). *R* refers to reappearance and the latitude of Greenwich is assumed. Mercury rises at 3h. 27m. and 3h. 52m. at the middle and end of the month respectively, and is visible in the eastern sky before sunrise. The planet is in inferior conjunction on Aug. 2 and is stationary on Aug. 12. Venus is a conspicuous object in the west, its times of setting being 21h. 12m., 20h. 36m., and 19h. 53m., at the beginning, middle and end of the month respectively. During the month the stellar magnitude of Venus varies from − 3·7 to − 3·9. Mars can be seen in the earlier part of the month, setting at 21h. 18m. on Aug. 1, but as the planet sets 1h. 10m. after the sun on Aug. 15, it is not well placed for observation after that date. Jupiter sets at 22h. 04m. on Aug. 1 and can be seen in the western sky in the constellation of Virgo. Towards the end of the month the planet is drawing too close to the sun for favourable observation. Saturn can be seen in the morning hours, rising at 3h. 40m. and 2h. at the beginning and end of the month respectively. The stellar magnitude of Saturn varies from 0·4 to 0·5 during August. The Perseid meteors attain their maximum about Aug. 10–12, but moonlight will prevent observations of any but very bright meteors during this period.

Announcements

The Royal Society is prepared to consider applications, through fellows of the Society, for a contribution towards the cost of travelling expenses when a scientific worker is invited for a specific purpose overseas by a national academy or other scientific institution of high standing.

Dr. H. T. Openshaw, lecturer in chemistry in the University of Manchester, known for his research work in the field of alkaloid chemistry, has been appointed to the Purdie lectureship in the Chemistry Department of the United College of St. Salvator and St. Leonard, University of St. Andrews.

Dr. F. D. Richardson, of University College, London, and Commonwealth fellow at Princeton University, has been appointed head of the Chemistry Department of the British Iron and Steel Research Association. During the War Dr. Richardson, who is a physical chemist, served in the Royal Navy in a scientific capacity; he was associated with the development of equipment for dealing with magnetic mines, and eventually became deputy director of Miscellaneous Weapon Development.

On the recommendation of the honorary managing committee of the Bureau of Hygiene and Tropical Diseases, the Secretary of State for the Colonies has confirmed the appointment of Dr. Charles Wilcocks as director of the Bureau, and has appointed Dr. H. J. O'D. Burke-Gaffney to be assistant director. Dr. J. F. Corson, who since July 1943 had given his help as acting assistant director of the Bureau, retired on June 30, 1946.

The following have been elected officers of the Electrodepositors' Technical Society for 1946–47: *President:* Dr. S. Wernick; *Immediate Past President:* Dr. J. R. I. Hepburn; *Vice-Presidents:* Dr. H. J. T. Ellingham, Dr. G. E. Gardam, F. L. James; *Honorary Treasurer:* F. L. James; *Deputy Hon. Secretary:* S. W. Baier.

The McGraw-Hill Book Co., Inc., New York, will publish shortly the complete texts of the papers and centennial addresses delivered at the George Westinghouse Centennial Forum, "Science and Life in the World", held under the sponsorship of the Westinghouse Educational Foundation during May 16–18. These symposia and addresses will be issued in the form of five books. In addition to the papers and addresses, the books will contain biographies of all of the speakers, a biographical sketch of George Westinghouse and his achievements, numerous portraits, text illustrations, and most of the audience questions and speakers' answers relative to each of the several papers. A list of all papers and addresses can be obtained from the McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York.

LETTERS TO THE EDITORS

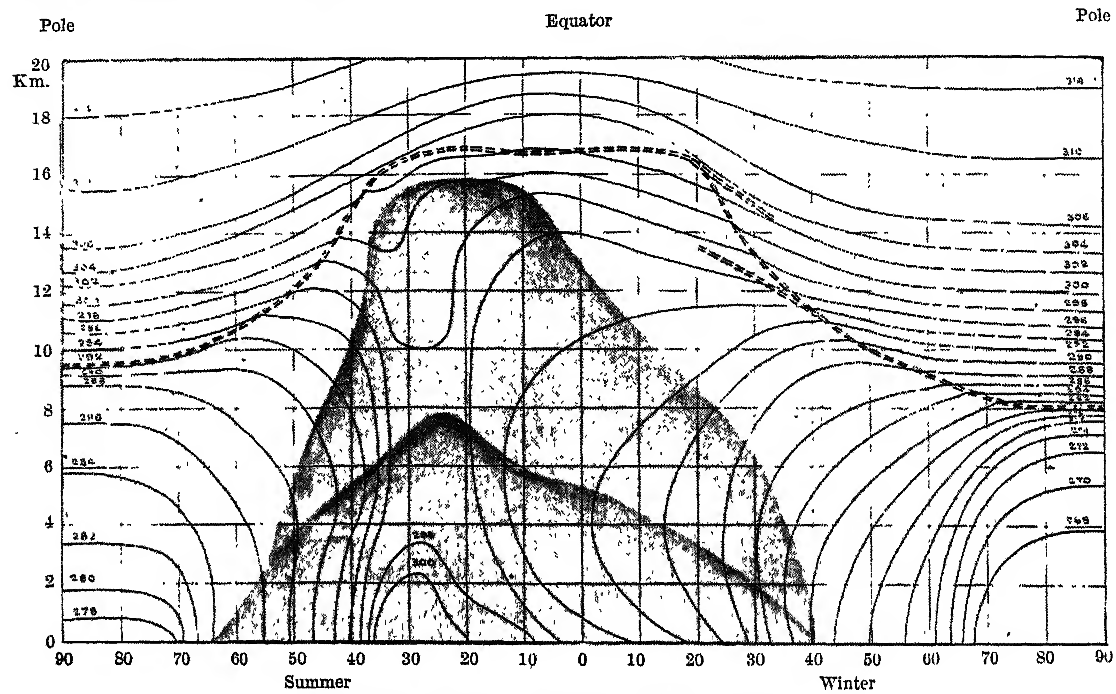
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Distribution of Wet Bulb Potential Temperature in Latitude and Altitude

If potential temperature is denoted by θ and wet bulb potential temperature by θ', then log θ is proportional to the entropy of dry air and log θ' to the entropy of the mixture of air and water vapour. Because air is compressible, entropy is a guide to its motion, and Sir

5. The shaded region nowhere extends into the stratosphere, the base of which is denoted by the broken double line. Over the thermal equator, however, the shaded area is seen to rise much higher than the polar stratosphere and almost to touch the equatorial stratosphere, thus giving support to the belief that convection is a main cause of the higher stratosphere over the equator. A critic may ask why, if this is so, the stratosphere is so much higher than the shaded convective area between lat. 10° and lat. 30° in winter; in other words, why is the convective region in this diagram so asymmetrical about the equator, whereas the height of the stratosphere is fairly symmetrical? This discrepancy is more apparent than real, at least in Indian longitudes, where the base of the stratosphere is always sharp and clear-cut and single-valued in summer, but is just one of several inversions in winter, from which the final choice is arbitrarily made by arithmetical rule rather than by any uniquely significant physical change.

It is to be noted that the tropical values in this diagram are drawn mainly from those of the Indian monsoon area, where the values of θ'



Distribution of wet bulb potential temperature (θ') with height

aloft are perhaps too great to be representative of all meridians. Between 1943 and 1945 the number of *radio-sonde* stations became so great that their unpublished observations may now be sufficient to show how the meridional sectional diagrams of θ and θ' vary from one meridian to another.

Napier Shaw was the first to prepare a diagram of the variation of log θ or θ with latitude and height, and to use it as a text on which to expound the stratification of the atmosphere. When, however, cloud in convection penetrates the air strata, log θ' takes the place of log θ as an operative factor. A world picture of θ' is required to complement that of θ.

During the War, we prepared the diagram that is reproduced here, basing it upon the upper-air humidity data then available in India, namely, those of Batavia, of Indian stations up to 1940, English and German data up to 1937, and American *radio-sondes* of 1939–41. The data therefore were not representative of a single meridian, but the requisite smoothing has, it is believed, conserved the main features of the distribution, which may be summarized as follows.

1. Around the thermal equator, where much of the heat in the lower layers is in the form of latent heat, the θ'-lines assume the shape of a fountain, in marked contrast to the θ-lines, which by themselves are more suggestive of horizontal stratification[1]. On the other hand, wherever the concentration of water vapour is small, as it is near the poles and near and in the stratosphere, the lines of θ' and θ approximately coincide.

2. At all levels below 8 km., θ' is maximum at the equator and minimum at the poles; but above 15 km. the minimum is over the equator and the maxima at the poles. Between 10 km. and 15 km. maxima occur both at the poles and near the equator, with minima between.

3. The lower shaded area around the thermal equator on the diagram marks out the region of *convective instability* within which θ' normally diminishes with height and the lapse-rate of entropy is negative. This region appears to stretch from about lat. 40° in winter to lat. 60° in summer and to rise to a height of 6–8 km. near lat. 20° in summer.

4. The upper shaded area marks off the region in which θ', though rising with height, is lower than the surface value θ'_0. The upper shaded boundary is drawn through the heights at which θ' is equal to θ'_0. For example, at the equator, θ' normally falls from a value of 295° A. at the surface to about 292° A. at 4 and 5 km., then rises slowly at higher levels and regains the surface value of 295° A. at a height of 13 km. When rising air becomes saturated, one would expect it normally to continue to rise out of the region of convective instability and to cease rising below the level at which θ' regains the surface value. The total shaded area of the diagram may be termed the region of convective liability.

C. W. B. Normand
K. Nagabhushana Rao

Cambridge.

Poona, India.
June 13.

[1] See Brunt, "Physical and Dynamical Meteorology" (2nd edn.), 415.

Research on Free Animals, with Particular Reference to Fisheries

Management of animals that are free to wander presents man with a difficult problem. The Fisheries Research Board of Canada has been attempting for a dozen years or so to make rapid progress in solving that problem for Atlantic salmon. A certain measure of success has been attained and a pattern for treatment of the matter has gradually developed.

There have been two objectives: the first has been to make the salmon available for the best use—for angling, in which they are of high value for sport as well as for food; the second has been to increase their numbers. The problem presents two great difficulties: (1) the complexity of conditions in Nature, and (2) enumeration of animals wandering in a medium (water) foreign to man. Practice in fishery management has largely been rational, that is, based upon reasoning from the limited knowledge available. Empirical practice, based upon successful trial, has had little chance to develop, owing to difficulty or failure in assessing the results. Scientific practice, in which the result is predicted accurately, and economic practice, in which there is a proper relation between effort and result, are only for the future.

Three courses are open. (*a*) Rational practice may be continued indefinitely, as governmental fish culture has been in Canada and the United States for more than seventy years. (*b*) Scientific workers

may with their limited knowledge of the factors involved and with very considerable effort assess the result in a sufficiently great number of cases for statistically sound practice or non-practice in relation to presumed factors. (c) By research it may be possible to discover the most significant factors as a basis for scientific practice with the possibility of developing economic practice. Only the last should be recommended by the scientific worker, except when empirical success warrants continuation of practice.

To make salmon available for angling, they must be brought into the river from the sea. For this, knowledge is required of the factors determining salmon migration. In spite of an outstandingly successful trial on the River Grimersta in 1888[1], regular empirical use of artificial freshets to bring salmon in from the sea has not developed[2], and the rationale of the action of freshets has not been worked out. This is perhaps owing to man's thinking being preoccupied with the idea that the mature salmon in the sea is trying to find its way back to its home stream and that the scientific problem is to discover how it finds its way[3]. However, the facts indicate that, when at the river mouth, salmon may not try to enter for weeks on end until stimulated in some way. A freshet may provide the stimulus. In the very dry summer of 1942 on the Moser River, Nova Scotia, sharp artificial freshets resulted in the numbers of entering salmon and 'brook trout' (*Salvelinus fontinalis*) being doubled, as judged by the preceding three years[4]. This would not have been possible if these fish return only to the home stream. (Smolt marking indicated the next year that almost half the salmon were foreign.) High temperatures (higher than 70° F.) were considered responsible for the fact that very few of the salmon crowding the small river were taken with the fly. In 1943, the freshets were started as soon as salmon were moving in the estuary, and within a month a quarter of 474 salmon that had entered were taken by angling[5]. Then, a heavy flood and rising temperature stopped the angling and swept away counting fences and traps. Regular practice in water control is in prospect, and attempts are being made to elucidate factors that determine migration, such as current, turbulence, temperature, light and salinity.

To increase the salmon stock demands knowledge of the factors determining survival and growth of the fish. Since a female produces thousands of eggs, supply of new individuals is not apt to be much of a problem. Experiments are in progress to discover how cheaply salmon smolts can be produced in streams lacking native young salmon, by planting the young from hatcheries. Unless they can be produced economically as a preliminary to getting adult fish, there is no object in trying to compete with natural reproduction by planting hatchery fish in streams with native fish. Very great complexity of conditions in each stream makes scientific progress slow. Assessment of smolts, which was thought at first to be easily feasible by trapping them during descent, has given considerable trouble: (1) through failure of the trapping, as during heavy floods; (2) through the smolts not all descending, as with very low water or from above beaver dams; and (3) through anglers sometimes (low water) taking a very large proportion of them, and sometimes (high water) taking none. Assessment in the parr stage is seen to be needed and is being attempted. As the parr wander more or less, knowledge is required of the factors affecting not only their survival and growth, but also their movement. So far, predators are seen as the main explanation of disappearance of parr, so that control of bird predators[6] and provision of protective cover for the parr[7] are seen as promising practices.

This is an ecological problem, and the crux of it seems to have been given very little attention, doubtless because of the difficulties involved. In every case, the outcome depends upon *the response of the animal as a whole to what it faces where it lives*. To refer readily to this, a name is needed. 'Zoapocrisis' (ζῷον = animal, ἀπόκρισις = response) has been suggested. Its elucidation requires rather detailed knowledge of what the animal actually faces where it lives, which presents an initial task that is far from being an easy one. As an illustration, it is becoming apparent that salmon are, when in the sea, oriented riverward where there is a sufficiently steep gradient in salinity. Also, salmon evidently respond to current, which will take them upstream, only when it is sufficiently and finely turbulent. Zoapocrisis presents an almost virgin field for discovery.

A. G. HUNTSMAN

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at the University of Toronto.

[1] Calderwood, W. L., "The Salmon Rivers and Lochs of Scotland", 312 (London, 1921).
[2] Coston, H. E. T., Pentelow, F. T. K., and Butcher, R. W., "River Management", 245. Philadelphia (Edinburgh, 1936).
[3] Chidester, F. E., *Brit. J. Exp. Biol.*, 2, 79 (1924).
[4] Huntsman, A. G., Ann. Rep. Fish. Res. Bd. Canada, 1942, 29 (1943).
[5] Huntsman, A. G., Ann. Rep. Fish. Res. Bd. Canada, 1943, 34 (1944).
[6] White, H. C., *Bull. Fish. Res. Bd. Canada*, 58 (1939).
[7] Huntsman, A. G., Ann. Rep. Fish. Res. Bd. Canada, 1945, 32 (1946).

Establishment of Cytochemical Techniques

In his article on the "Establishment of Cytochemical Techniques"[1], Dr. J. F. Danielli directly or by inference questions the validity of very nearly the whole of cytochemistry. While there is no doubt that many workers have used cytochemical methods without fully considering the evidence for their validity, we feel that Dr. Danielli has gone to the opposite extreme.

Some of the tests that he mentions are usually made on fixed materials, where it must be supposed that part at least of the cell has been made insoluble. This process will cause just as much adsorption and shifting of substances as any cytochemical test applied afterwards. While it may be argued that artificial appearances are produced, yet something is shown that can be interpreted later in the light of our knowledge of the effects of reagents on cells. Every procedure that involves fixation is itself an experiment on a cell. The appearances produced by classical cytological methods do not represent exactly the structure of the living cell, but they enable us to make inferences about that structure. The same argument applies to cytochemical techniques.

The images given by different processes of fixation and staining are often so similar that one can scarcely doubt that the picture of the fixed material bears a close relation to the living structure, whatever the submicroscopic changes may be. For example, in the case of salivary gland chromosomes, different fixatives may be used, or unfixed cells may be photographed in ultra-violet light, and the picture is essentially the same.

The fact that the bands in salivary gland chromosomes that react positively to the Feulgen test correspond exactly to those that strongly absorb ultra-violet light of 2675 A. must mean one of two things: either (1) the bands that absorb ultra-violet light contain desoxypentose nucleic acid, or (2) the 'diffusible' Feulgen reaction product always diffuses to those very places that have an absorption spectrum that indicates that they could contain nucleic acid. The principle of 'Occam's razor' surely decides in favour of the first alternative. If the reaction product is in fact diffusible in the circumstances under which the test is performed, are we to suppose that it diffuses into the fluid in the jar in which the reagents do their work and then attaches itself to certain other parts of the cell selectively? Or does it migrate through the section? The first alternative seems unthinkable, for the reaction product would be far too dilute to produce a perceptible result; and the second is also very unlikely, because if the reaction product can diffuse through the tissues away from the place where it was first formed, it can also diffuse into the fluid in the jar and thus be lost.

It must be allowed that metallic impregnations are far less trustworthy than staining methods. The minute structure of a metallic precipitate is irrelevant. The position of the precipitate as a whole within the cell, however, is not necessarily so.

Dr. Danielli seems to doubt whether nuclei can in fact be isolated by maceration. In certain cases they cannot; but there seems to be no doubt that when the cell membrane is weak and the nuclear membrane strong, such isolation is possible. It is true that nuclei may be changed by such isolation, but there is no special reason for supposing that the process would cause substances formerly present in the cytoplasm to migrate into the nucleus and collect there in appreciable quantities. This would be particularly unlikely in the case of substances with large molecules. The identification of isolated mitochondria is less certain than that of nuclei, but when the shape, size and staining reactions resemble those of mitochondria *in situ*, there is a high degree of probability as to their identity; in fact, there are not many more bases on which identity could be assumed. It is a debatable point, however, whether the submicroscopical particles exist as such in the living cell.

Dr. Danielli's criticisms of maceration techniques apply as much to bio- as to cyto-chemistry, for many of the classical biochemical methods of making tissue extracts are themselves maceration procedures.

It is true that many enzymes are not specific as to substrate; but ribonuclease, a depolymerase, is highly specific for ribonucleic acid. There may be slight proteolytic activity even in crystalline preparations, but this is destroyed by heating to 80°–100° C. at slightly alkaline *p*H, while the action on ribonucleic acid remains intact. Purified enzymes are beginning to open out a new and promising line of attack on cytochemical problems. Long ago, Unna thought that one could stain a particular object in a cell, apply various solvents, and then draw conclusions as to the chemical composition of the object from a knowledge of its solubility or insolubility. We know now that Unna's 'chromolysis' was invalid: the solubilities of cell-constituents are profoundly changed by association with other substances. Reactions to certain purified enzymes, however, are invariable, and thus a new and valid chromolytic cytochemistry is made possible, the lysis being achieved by the action of enzymes instead of solvents.

Dr. Danielli suggests that if an object were composed of nucleic acid, but were covered by a monolayer of protein, nuclease would be unable to exert any effect. We question the existence of such monolayers in the fixed tissues to which the nuclease is applied.

Although we cannot accept all Dr. Danielli's criticisms, for the reasons we have given, yet we fully appreciate the need for greater care in accepting the results of cytochemical tests at their face value. We think, however, that the tests themselves should be the main targets for criticism, rather than the localization of the reaction products. We suggest that any change of position, particularly in the case of large molecules, may be an affair of A. rather than of μ; and it is with μ that cytologists are at present concerned. Many so-called histochemical and cytochemical tests are used without full consideration of the bases of their supposed validity. If Dr. Danielli's article encourages a more critical attitude in this respect, it will serve a very useful purpose.

We thank Prof. A. C. Hardy, Mr. P. B. Medawar, Dr. G. Bourne and Mr. A. J. Cain, with whom we have discussed Dr. Danielli's article.

JOHN R. BAKER
F. K. SANDERS

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University Museum,
Oxford.
June 15.

[1] Danielli, J. F., *Nature*, 157, 755 (1946).

WHILE I welcome a measure of support which Drs. Baker and Sanders give to my criticisms of cytochemical techniques, their letter leaves no doubt that the principle underlying my article has evaded them. My remarks do not, and were not intended to, invalidate "nearly the whole of cytochemistry". What my article does is point out that, in cytochemistry, too much reliance has been placed on arguments which have not been rigorously demonstrated as true. There are suggestive inductive arguments in favour of many techniques in current use, and these arguments have in the past been of great value as a guide to further research. But the time has now come when their premises must be critically examined by experiment,

and the range of their validity established by deductive reasoning. As this is the main point at issue, I shall not endeavour to answer Drs. Baker and Sanders point by point, but shall restrict myself to illustrating the difference in our points of view from three of their points, one of which is a false deduction; the others illustrate the weakness of induction.

1. Drs. Baker and Sanders are strongly tempted to deduce that all regions absorbing strongly in the vicinity of 2675 A. must contain desoxypentose nucleic acid. This is not the only possible deduction. Absorption at 2675 A. is a characteristic of purine-pyrimidine and other groups, so that many compounds other than nucleic acid may absorb in this region. Thus a possible alternative cause of absorption in this region would be the presence of a protein containing purine-pyrimidine groups. Between this and nucleic acid there is a profound difference. To proceed with their argument on this matter, the principle of 'Occam's razor' is invoked. But this principle cannot be used to decide which of two alternatives is true. The correct use of the principle is in deciding which alternative appears the more sensible working hypothesis to adopt. That Feulgen's reaction indicates the site of desoxyribose nucleic acid seems to me to be a very sound working hypothesis. But let us not elevate this hypothesis to the plane of fact without conclusive (and this at the moment means new) evidence.

2. Apropos of my point that a monolayer of protein would protect nucleic acid from the action of nuclease, these authors remark, "We question the existence of such monolayers in the fixed tissues". But it is not sufficient to question their existence. The facts of Nature are not affected by questioning. What is established is that monolayers of protein exist in cells, and no one who has had practical experience in studying these monolayers can fail to be impressed by the mechanical strength they may exhibit[1,2]. What is necessary is investigation of the extent to which protective action against enzymes is in fact provided by monolayers and thin polymolecular layers.

3. Consider one of Drs. Baker and Sanders' final remarks: "We suggest that any change of position, particularly in the case of large molecules, may be an affair of A. rather than of μ". How very much simpler cytochemistry would be if we were certain this were true! And how difficult it is to establish this for any particular molecular species! But, as my teacher, N. K. Adam, once remarked to me (with due cause), that a task is difficult does not make its performance any the less essential.

Every cytologist must appreciate the valuable contributions of Drs. Baker and Sanders to cytology. I am most appreciative of the interest they and their distinguished colleagues have taken in my views, and regret that I had not made the main point of my article clearer to them.

J. F. Danielli

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Citadel Hill,
Plymouth.

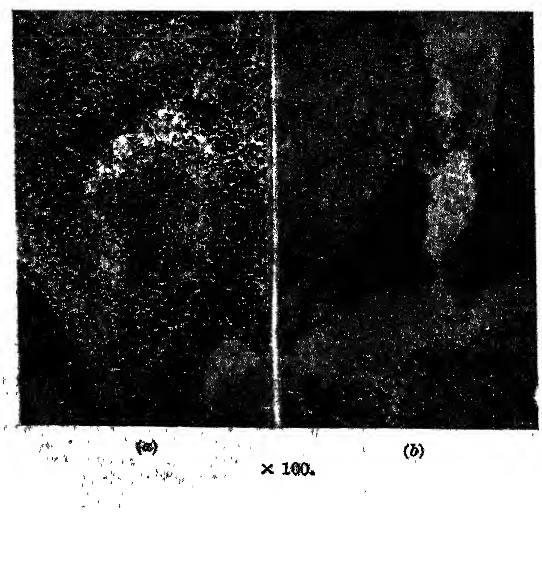
[1] Harvey, E. N., and Danielli, J. F., *Biol. Rev.*, 13, 319 (1938).
[2] Höber, R., "Physical Chemistry of Cells" (Philadelphia: Blakiston, 1945).

Source and Fate of the Zooxanthellæ of the Visceral Mass of *Tridacna elongata*

Zooxanthellæ have been recorded from the visceral mass of *Tridacna* by Yonge[1], who assigned to them together with those of the mantle edge a very significant role in nutrition. According to this author the zooxanthellæ are transported, by means of the blood-cells via the blood stream, from the mantle edge where they are 'farmed' to the visceral mass where they undergo phagocytic digestion.

The food and the digestive processes of the Lamellibranchiata in general and *Tridacna* in particular were referred to in my previous communication[2]. As to the blood-cells and the blood-stream being means of transportation of the zooxanthellæ from the mantle edge to the visceral mass, it must be mentioned that in both *Tridacna elongata* and *T. squamosa* the zooxanthellæ in the mantle edge were never seen within amœbocytes, nor was the blood in the heart or in the main vessels ever found containing zooxanthellæ of any description.

Examination of a number of specimens of *Tridacna elongata* differing in age showed that it is only in the visceral mass of young individuals that the zooxanthellæ actually occur. In the youngest specimen examined (2 cm. in length) the zooxanthellæ were found in the delicate layer lining the muscular wall of the visceral mass, especially in the dorsal region below the heart. In this site the zooxanthellæ are free not engulfed, in amœbocytes, but simply exist in the meshes of this very delicate layer where they form a distinct bed reaching in some places eight zooxanthellæ in depth. In such young specimens zooxanthellæ, either free or within amœbocytes, were found also in the deeper regions of the visceral mass. Here also some zooxanthellæ were found in groups surrounded by aggregations of both ordinary and granular blood-cells. In slightly bigger specimens (5 cm.) the zooxanthellæ-bed referred to above was comparatively thin. In the same specimens, the groups of zooxanthellæ surrounded by blood-cells showed definite signs of degeneration (Fig. *a*). In still bigger specimens (10 cm.) the delicate layer lining the muscle-wall was found to be almost free of zooxanthellæ while the surrounded zooxanthellæ were reduced to a mass of unrecognizable debris.



(*a*) × 100. (*b*)

This debris seems to be cleared out mainly through the agency of the kidneys. Paired well-defined openings (Fig. *b*) were found to put in direct communication with one another the cavity of the visceral mass and the intertubular spaces of the kidneys. Through these openings pass numerous zooxanthellæ, whole or in different stages of destruction, as well as plenty of debris-loaded blood-cells.

It is clear, therefore, that the zooxanthellæ in question are quite independent of those of the mantle edge. In all probability they started life in the visceral mass itself after a separate infection at an early stage. With the growth of the animal, the light penetrating into the visceral mass decreases, to the detriment of these zooxanthellæ, and thus the blood-cells are given a chance to clear them out of this region of the body in the way mentioned above.

The processes leading to the ultimate disappearance of the zooxanthellæ and their remains after transportation to the kidneys are still unknown.

K. Mansour

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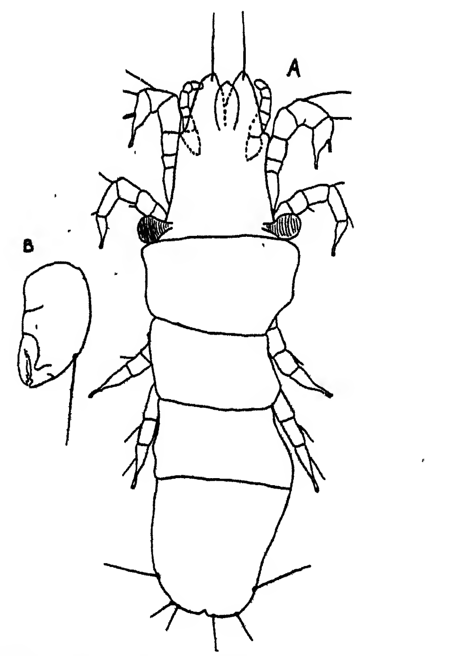
Fouad I University,
Cairo.
June 9.

[1] Yonge, C. M., Great Barrier Reef Expedition Sci. Rep., 1, No. 1 (1936).
[2] Mansour, K., *Nature*, 157, 482 (1946).

A New Acarine Parasite of Bees

While conducting a survey of the ectoparasites of bees in and about Durban, Natal, during 1940, five specimens of the adult females of a remarkable new acarine were collected from two species of bees, *Apis unicolor* var. *adamsoni* Latr., and *Anthophora fallax*.

The female, which shows very definite segmentation, presents the general facies of the family Tarsonemidæ and is provided with large pseudostigmatic clavate organs as shown in the drawing, between legs I and II.



Pediculochelus raulti sp. nov.: (*a*) female in ventral view; (*b*) 'pincer' of chelicera in side view

The mouthparts, however, revealed the most extraordinary features. The chelicerae instead of being very slender and needle-like, as in the Tarsonemidæ, are powerful structures consisting of two arms, the movements of which take place in a vertical direction. They resemble very powerful pincers. It is interesting to note that the upper arm of each chelicera is provided with a prominent seta as shown in the accompanying figure. The palps are not filiform but free and limb-like, being divided into six distinct segments.

There are four pairs of well-developed legs. No claws could be distinguished, but the legs terminate in a sort of sucking disk. It was impossible to find any trace of a respiratory system.

The genital opening, which is located just behind the level of coxal IV, is represented by a longitudinal slit with a pair of minute sucker-like structures on each side. As can be seen in the accompanying figure, the anus is terminal.

These mites are extremely minute, measurements of four specimens studied being as follows.

Specimen	I	II	III	IV
Length	240 μ	196 μ	184 μ	220 μ
Breadth	64 μ	56 μ	64 μ	48 μ

The length was measured from the tip of the cheliceræ to the tip of the abdomen; the breadth at the level of leg II.

No males were recovered, though a large number of bees were examined.

A new family Pediculochelidæ and genus *Pediculochelus* is erected to receive this most interesting species, which is named *Pediculochelus raulti* after Mr. P. Rault, of Mount Edgecombe, who was instrumental in discovering the new species.

A further communication will appear shortly.

MICHEL LAVOIPIERRE

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Johannesburg.
May 20.

A New Method for the Study of Renal Tubular Excretion in Birds

THE existence of a renal portal circulation in birds has hitherto lacked experimental confirmation. In order to investigate this question, the following method has been adopted.

At each ureteral opening in the cloaca of a chicken, a small funnel is attached by sutures. The operation is performed under local anæsthesia of the cloacal mucosa. This arrangement permits the separate collection of the urine from each kidney. Phenol red is then injected intramuscularly into one of the legs, and the amount of the dye excreted by each kidney is determined.

In every instance far more phenol red (on an average about three times as much) is excreted by the kidney on the side of the injection than by the other. It is clear that at least part of the venous blood from the legs passes through the capillaries of the kidney.

The arrangement used in these experiments seems to be well suited to the study of tubular excretion. By using this method it has been possible to show that hippuric acid and menthylglucuronide are excreted by the tubules in the chicken. Hippuric acid depresses the excretion of phenol red and menthylglucuronide.

I. SPERBER

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June 4.

Transformation of the Kidney into an Exclusively Endocrine Organ

USING a special surgical technique, it is possible to transform one of the kidneys of the rat into an exclusively endocrine organ.

The technique is based upon the fact that, in order to permit filtration, the hydrostatic pressure in the glomerular capillaries of the kidney must be much higher than in the other capillary territories. Indeed, it is indispensable for urine formation that the hydrostatic pressure in the tuft capillaries be greater than the sum of the osmotic pressure of the blood and the hydrostatic pressure of the filtrate in the spaces of Bowmann's capsules.

By placing the style of a subcutaneous injection needle parallel with the aorta and tying a silk thread around both aorta and style, a partial constriction of the aorta can be obtained which decreases the lumen approximately to the width of the style. The latter is subsequently removed, so that circulation re-establishes itself, but the constriction, if placed between the origins of the two renal arteries, decreases the pressure in the left (lower) renal artery far below the level required for normal filtration. By choosing styles commensurate with the size of the rat, it is possible to decrease filtration pressure exactly to the level where urine formation ceases, but the nutrition of the renal parenchyme does not suffer.

Since the exact gauging of the degree of constriction needs considerable practice, a greater safety margin may be secured by simultaneously occluding the left ureter, transecting it between two ligatures. Under such conditions, a slight and transitory hydronephrosis builds up some hydrostatic pressure; but afterwards, when filtration ceases and the fluid in the renal pelvis is absorbed, the kidney is transformed into an exclusively endocrine organ. Ureter occlusion without preliminary arterial constriction would result in pronounced and permanent hydronephrosis with pressure atrophy of the entire renal parenchyme.

Histological study has shown that the tubular epithelia of such kidneys lose their brush border, and the lumina of the nephrons become filled with proliferating, well-preserved parenchymal cells. Treatment with renotrophic steroids or renotrophic pituitary extracts may even induce active mitotic proliferation in the completely 'endocrine kidney'.

The increased pressor substance production of such kidneys manifests itself, within a period of about ten days, by the development of myocarditis, nephrosclerosis of the contralateral kidney and widespread periarteritis nodosa. No such lesions are observed if the 'endocrine kidney' is removed, and hence these pathological lesions are regarded as due to the increased hormone production of the transformed kidney

A detailed communication on this subject will appear in the *Journal of Urology*.

HANS SELYE

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June 25.

Reciprocal Effects due to Stimulation of the Spinal Cord by Constant Currents of Opposite Direction

ALTHOUGH the occurrence of slow electrotonic potentials which act as exciting agents has been demonstrated in the spinal cord, only a few investigations in which the cord was stimulated artificially by constant currents have been reported. Barron and Matthews[1] showed that polarization of the central part of the motor neurons evoked rhythmical responses when the cathode was placed on the cord and the anode on the root, whereas regular responses were only occasionally obtained if the current was reversed.

In the course of an analysis of the activity in the spinal cord, in which a special technique[2] involving stimulation with slowly rising currents was used, I observed that the extent to which extensor and flexor responses predominated was partly determined by the direction of the stimulating current. Many different electrode positions were tried, but only the results from a few typical arrangements will be described here. In ten cats the lumbar region of the spinal cord was exposed and the dorsal roots cut, while in five others the ventral surface of the medulla and the cord between the base of the skull and the first vertebra was laid bare and the dorsal roots left intact. The strength of the stimulating current was gradually increased to threshold and supra-threshold values. In some experiments a simultaneous recording of the action currents from two opposed muscles was made; in others the effects were determined by observation of the movements of the intact leg.

In one arrangement, in which both stimulating electrodes were placed on the lateral surface of the lumbar cord, one above the other and several centimetres apart, it was found that when the upper (cranial) electrode was the anode, stimulation with currents of moderate strength caused extension, while a reversal of the current gave flexion of the corresponding hind leg. When only one electrode was placed on the cord (near the entrance of a motor root) and the other (indifferent electrode) on the dorsal muscles, the effects were most pronounced in the extensors when the cord electrode was positive and in the flexors when it was negative. The reciprocal effects were more or less selective in different experiments. In some of these, in which the muscle action currents were recorded, considerable activity was found in the active muscle (for example, tibialis anticus) but none in the opposing muscle (soleus). However, if the stimulation was sufficiently great, both groups of muscles were activated. Under some conditions, breaking the current produced an effect in the muscles opposed to those activated during the current flow.

When the stimulating electrodes were placed on the cord or the medulla below the decussation of the pyradimal tracts, the reciprocal effects were still more pronounced. With one electrode on the cord, some millimetres from the mid-line, a pronounced extension of both fore and hind legs of the same side was produced if the active electrode was the anode, while flexion resulted from a reversal of the current. If both electrodes were placed on the cord at the same level, the positive on one tract and the negative on the other, an extension of the limbs on one side simultaneously with flexion on the other was observed. Selective responses to different directions of the stimulus in functionally different parts of one and the same muscle were also seen.

The effects described may be due either to different inherent properties of the excitable structures (cf. Skoglund[3]) or to differences in anatomical orientation of the elements in relation to current flow.

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[1] Barron, D. H., and Matthews, B. H. C., *J. Physiol.*, **92**, 276 (1938).
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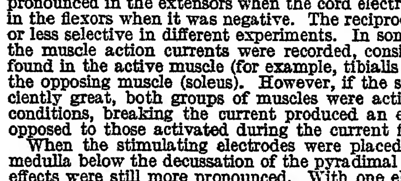
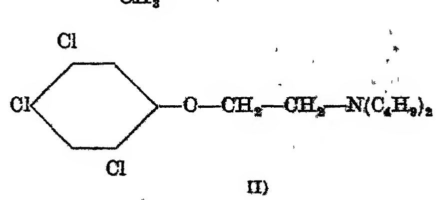
The Thyroid and Tuberculosis

NOLAN and his co-workers have described[1,2,3] the isolation from the lichen *Buellia canescens*, of diploicin, and from constitutional studies have provisionally assigned to it structure I. Diploicin is insoluble



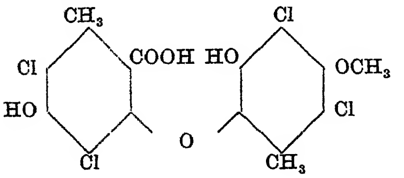
(I)



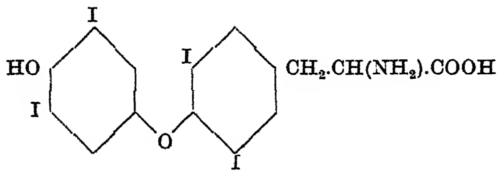
II)

in water, and for this reason its antibacterial activity was not examined by us *in vitro*. Iodinated and chlorinated phenyl ethers of type II have been shown, however, by Burger, Brindley, Wilson and Bernheim[4] to have tuberculostatic activity *in vitro*. A closer study of the diploicin molecule was, therefore, considered desirable.

As every position in the benzene nuclei in I is occupied, the simplest method of rendering the molecule soluble is by opening the depside ring, thus introducing an extra phenolic hydroxyl and a carboxyl group into the molecule. When this change is brought about by the action of alcoholic potash, under mild conditions, an ester is formed. With aqueous alkali, however, a solution of the sodium salt of the acid is readily obtained. A neutral solution of this compound, III, inhibits completely the growth *in vitro* of *Mycobacterium smegmatis* at a dilution of 1/70,000 and *Myco. tuberculosis* at a dilution of 1/100 000 for 42 days.



(III)



(V)

The carboxyl group in III is very unstable and in the presence of alkali readily loses carbon dioxide, forming a decarboxylated compound, IV, which is very much less soluble. It has not, however, suffered any diminution in antibacterial power. It is of interest that both III and IV inhibit completely the growth *in vitro* of *Corynebacterium diphtheriæ* (*mitis*) at a dilution of 1/100,000.

The only known substance, of the halogenated diphenyl ether type, occurring normally in the animal body is thyroxine (V), and its resemblance to diploicin suggested to me that hyperactivity of the thyroid gland, resulting in excessive secretion of thyroxine, might provide a defence against the spread of tubercular infection in the animal body.

Subsequent examination of the literature has shown considerable evidence that tuberculosis rarely develops in association with hyperthyroidism, and that the thyroid gland is seldom attacked by tuberculosis. It is also believed that hypothyroidism predisposes to tuberculosis[5].

The experimental fact which would serve as a connecting link between diploicin and thyroxine has not so far been found. Thyroxine does not appear to exert any effect on the growth *in vitro* of the tubercle bacillus. Neither has it been possible to show, so far, that oral administration of diploicin to guinea pigs produces any of the symptoms usually associated with hyperactivity of the thyroid gland. A limited animal protection experiment with diploicin is at the moment being carried out.

The amount of thyroxine in the animal body at any time is probably too small, in any event, to have a direct effect on the tubercle bacilli, and possibly the resistance to the spread of tubercular infection in hyperthyroid cases is due to an indirect action as, for example, the hyperplasia of lymphoid tissue which takes place. While admitting that the hypothesis may prove to be invalid, the coincidence is too striking to be passed over without thorough investigation.

I am grateful to the Medical Research Council of Ireland, which is financing this investigation, and to Dr. P. A. McNally, Trinity College, Dublin, who is carrying out the biological tests. Prof. J. Algar is at present engaged in completing the work of Nolan *et al.* on the structure of the diploicin molecule.

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June 22.

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An Anti-Tick Salve for Lambs

THE salving or smearing of sheep in autumn was part of the normal routine on sheep-farms in Scotland during the latter half of the eighteenth century. For reasons of cost and the labour involved, this practice fell into disuse about 1860, except in the County of Sutherland, and was regarded as of merely historical interest by 1900. Although it is customary to regard this old practice as being devoid of any rational basis, such an assumption is incorrect, since it was generally recognized that, as well as receiving increased protection from adverse weather, salved sheep yielded heavier fleeces of washed wool than sheep whose fleeces had not been 'laid', when the animals were herded under comparable conditions.

One of the main purposes of salving, however, was to combat external parasites; and, although the subject is controversial it may not be entirely fortuitous that complaints of losses from 'trembling' *rise* steadily during the years following the cessation of this ancient practice in sheep husbandry. It is now known that the sheep tick, *Ixodes ricinus*, is involved in the transmission of three fatal or highly debilitating diseases of sheep, namely, (i) trembling or louping-ill, (ii) tick-borne fever, and (iii) tick-pyæmia; but whereas measures have been devised which give considerable protection to adult sheep against these diseases or their vector, no really effective and practical measure for lambs has hitherto been found.

With the objective of remedying the defect, field trials were conducted this spring in west Perthshire, Argyll and Islay, using an anti-tick salve on lambs throughout the seasonal period of tick activity—a period which closely coincides with the lambing season. In former times, the standard smear or salve consisted of a mixture of lard and wood-tar (applied to the skin after parting the wool at intervals of about two inches), but in the above trials the salves used were—(*a*) dibutyl phthalate, 20 per cent; and (*b*) dibutyl phthalate, 10 per cent plus D.D.T., 10 per cent; both chemicals being incorporated in a lanoline base. The salve was applied to the lambs on the regions of the body where ticks tend to congregate, namely, lower jaw, ears, belly, legs and particularly the axillæ and groin. Each lamb received 2 oz. of salve within four days of birth, although experience indicates that 1·5 oz. is enough.

From the results of salving 160 lambs in heavily tick-infested districts, it was found that the lambs were given a very high degree of protection from ticks for one month, and considerable protection for an additional fortnight. An unexpected feature is that the two salves are almost equally effective. These salves are, therefore, valuable aids in protecting lambs from the direct and indirect effects of 'tick-bite', during the most critical period of their lives: and should greatly minimize the inordinate losses and unthriftiness among hill-lambs.

I take the opportunity of expressing my thanks to Dr. D. D. Pratt of the Chemical Research Laboratory, Teddington, for his invaluable assistance, and also to the agricultural organisers in the respective counties for their enthusiastic co-operation.

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June 21.

An Agent Delaying the Absorption of Penicillin

THE rapid absorption and excretion of penicillin necessitates frequent injections at short intervals. Polyvinyl alcohol and a beeswax-peanut oil mixture have been suggested as agents causing slow release of injected penicillin. The successful use of the beeswax-peanut oil mixture, and a number of reports in the literature, seem to point to the advantage of suspended dry penicillin in a water-free base. The beeswax-peanut oil mixture has the disadvantage that the insect wax is foreign to the mammalian body. In the preparation described below, a highly purified fat, extracted from normal mammalian depot fat, is used in a certain mixture with peanut oil. In this way the portion which has the higher melting point is not foreign to the body. Peanut oil has a low melting point and is known to be easily dealt with in the body.

Depot fat from oxen was carefully freed from connective tissue, blood, etc., finely cut and extracted with acetone in a Soxhlet apparatus. The extract was dried under reduced pressure. The dried material was then extracted with ether in a Soxhlet, the extract dried with anhydrous sodium sulphate and the ether removed under reduced pressure. The melting point was adjusted to 35–36° by addition of peanut oil. The preparation was sterilized and further dried in a dry oven (45 min., 160°). This altered the melting point but little. Finely powdered penicillin was suspended evenly throughout the molten mixture at 37°, approximately 50,000 units/ml. For injection the preparation was melted again in a water bath. Controls received the same amount of penicillin in an aqueous solution.

Owing to a fortunate hysteresis, the once molten mixture solidified much below its melting point. The needle only needed slight warming, and injection was easy by means of a syringe which was not warmed beforehand. The molten mixture passed easily through needles of a size often used for injections in man (8/10 mm.).

Blood was taken from the rabbits by cardiac puncture under sterile conditions, at intervals after the injection. Typical results (penicillin units/ml. serum) are shown in the following table.

Hours after subcutaneous injection (45.000 units)	3	4	6	8
Control		<0·03	<0·03	<0·03
Slow release prep. No. 3	1·06		0·26	0·06
Slow release prep. No. 3	1·06		0·26	>0·03
Slow release prep. No. 4		1·06		0·26

In no case was a local irritation, or indeed any marked reaction, seen on the site of the injection, at various intervals after it. Fourteen days after injection of 2·5 ml. into one rat, only small round and oval particles with smooth surfaces were found locally. To the naked eye these appeared very much like normal depot fat. Sections stained with Ehrlich's hæmatoxylin and Sudan IV showed no trace of local inflammation or any pathological reaction around the numerous fat particles; the immediately adjoining muscle and connective tissue were of normal appearance.

We are greatly indebted to Dr. A. P. Peeney of the Department of Bacteriology, Queen Elizabeth Hospital, for having determined the

concentrations of penicillin in the rabbit sera. Trials on man are being carried out by Dr. Peeney, and will be communicated by him. We are also indebted to Mr. G. A. Rowe for the histological sections, and to Glaxo Laboratories for presenting us with a generous supply of penicillin.

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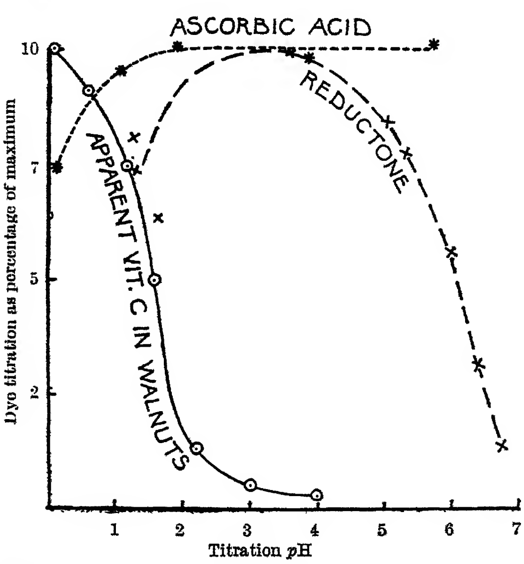
Effect of pH in the Dye Titration of Vitamin C in Certain Plant Materials

IN the estimation of vitamin C in plant materials by titration with 2 : 6 dichlorophenolindophenol, it has hitherto been generally assumed that the dye titration value is sufficiently independent of the titration *p*H to make it unnecessary to control the latter at all precisely. The usual procedure of preparing extracts with metaphosphoric or trichloracetic acid solutions to inhibit the action of ascorbic acid oxidase results in a *p*H which may range from 0·8 to 1·5, or even higher, according to the experimental conditions.

So far as ascorbic acid *per se* is concerned. this assumption may be justified by the findings by Martius and Euler[1] in 1934 that the dye titration value is practically constant from *p*H 4 down to *p*H 2, and then falls only slightly until the *p*H is reduced well below 1. When, however, ascorbic acid is being estimated in the presence of certain substances such as reductone, it has to be borne in mind that the dye titration value of the latter is not so constant as that of ascorbic acid. Martius and Euler found that under certain conditions the dye titration value of reductone falls rapidly as the *p*H is lowered below its optimum of 3–4, and that at *p*H 1 it might be decreased by 30 per cent. Their results for reductone and ascorbic acid are collated in the accompanying graph, and are in general agreement with results obtained here.

Recent work in these laboratories has shown the presence in different walnut extracts of a non-specific dye reductant clearly differentiated from ascorbic acid spectroscopically and by its reaction with formaldehyde and ascorbic acid oxidase and closely resembling reductone in its properties, especially in regard to its reaction with the above dye. It differs from reductone in the effect of *p*H on its dye titration value, which is at a maximum at a *p*H below 0·2–0·3 and falls as the *p*H rises until it reaches a minimum at *p*H 3·5–4·0. The graph includes a typical curve obtained with an extract of the mesocarp of *Juglans regia*, in which ascorbic acid had first been removed by treatment with formaldehyde at *p*H 4·5. (This treatment has no appreciable effect on the non-specific dye reductant, which is practically unattacked by formaldehyde during the time necessary for carrying out an estimation.) The results were obtained by visual and potentiometric methods previously described[2], and have been confirmed in numerous experiments on different walnut tissues in which the titration time ranged from 1 to 11 minutes. Taken in conjunction with the findings of Martius and Euler they indicate that:

(*a*) When ascorbic acid is being estimated by the dye titration in materials containing interfering substances such as have been encountered in walnuts, considerable errors may be caused by failure to allow for the effect of the titration *p*H, especially with a method employing titrations at two widely different *p*H values[3]. This may, in fact, explain certain discrepancies previously encountered[4] between results given by different methods.



EFFECT OF TITRATION *p*H ON DYE TITRATION VALUE OF ASCORBIC ACID AND REDUCTONE (TAKEN FROM DATA OF MARTIUS AND EULER) AND OF APPARENT VITAMIN C IN WALNUTS (OBTAINED BY DESTROYING TRUE VITAMIN C WITH FORMALDEHYDE AT *p*H 4·5)

(*b*) Walnuts may contain interfering dye reductants other than the glucoreductone and closely related compounds such as reductic acid and dihydroxymaleic acid, which are sometimes included in the generic term 'reductones'. In order to avoid premature conclusions, it would therefore seem advisable at present to avoid applying the name 'reductones' to substances in walnuts.

Full details of these results will be published elsewhere.

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June 25.

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Enzymic Oxidation of Ascorbic Acid by Apples

IN 1937, Johnson and Zilva[1] confirmed the fact that cabbage, cauliflower, cucumber and marrow contained an enzyme capable of oxidizing ascorbic acid directly, but reported that no such enzyme could be found in apple or potato. In respect of apples they pointed out that in the presence of catechol or of apple juice, the phenolases of apple oxidized ascorbic acid indirectly, but that ascorbic acid oxidase activity could not be demonstrated in the absence of phenolase activity, either in crude juice, filtered juice, or tissue extract.

Experiments carried out in this laboratory on the respiration of slices of apple tissue indicated that in Granny Smith apples ascorbic acid might be directly oxidized by an enzyme. The presence of this enzyme was confirmed by cutting Granny Smith apples into small pieces, freezing them, and expressing the juice by squeezing the tissue through muslin. The filtered juice oxidized ascorbic acid but showed no phenolase activity. Filtered juice which had been boiled for a few seconds showed very little activity towards ascorbic acid. The rate of oxidation was measured in a Warburg apparatus.

Attempts to isolate the enzyme responsible for the oxidation of ascorbic acid, using the method of Tauber, Kleiner and Mishkind[2], have so far yielded precipitates with little or no activity, but by the use of Szent-Györgyi's method[3] precipitates of relatively high activity were obtained. The yields were of the order of 1 milligram of dry precipitate per gram of fresh tissue. At *p*H 5·9 and 25° C., the specific activity of the preparation towards ascorbic acid,

$$W, \left(\frac{\text{mm.}^3\ O_2 \text{ taken up}}{\text{mgm. enzyme} \times \text{minutes}}\right),$$

varied from 0·02 to 0·1. The enzyme preparation had no phenolase activity; this indicates that ascorbic acid was oxidized directly.

Enzyme preparations showing similar behaviour have been obtained from Jonathan and from Cox's Orange Pippin apples.

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[1] Johnson, S. W., and Zilva, S. S., *Biochem. J.*, **31**, 438 (1937).
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Thermally Evaporated Anti-Reflexion Films

IN a recent communication[1], J. Bannon has described a technique for hard-baking magnesium fluoride films on glass surfaces; this prompts us to discuss briefly our own experience.

These laboratories have been engaged in large-scale production of hard-bake magnesium fluoride since 1943. From this year until October 1946 both the quality of our films as well as the production efficiency has steadily improved. In the initial experiments we baked the films in an air oven at 390° C. for the harder glasses. For some reason not clearly understood, we were able to harden films deposited on the softer glasses at temperatures around 375° C. On the basis of our earlier attempts we believe that: (1) films baked in an air oven were not consistently satisfactory for mass production; (2) films were not so hard as the best which had been vacuum-baked; (3) the type of source, as well as the degassing procedure followed in conditioning the fluoride before coating, affects the hardness.

Although U.S. Army Specification No. 51-70-4B was used as a production check, it has been noticed that more than 90 per cent of our films are much more durable than the test would indicate. A really hard coating deposited on the hypotenuse of a 7 × 50 binocular prism, for example, when rubbed 20 cycles with the standard eraser at pressures of 10 lb. or more, should show no more hairlining than an uncoated prism treated in the same manner. The prism surface is viewed by internal reflexion under an inspection lamp.

The length of baking time does not influence the hardness. Indeed, in a well-degassed system, the glass can be coated immediately the working temperature (250°–300° C.) is reached. Longer baking may help to condition a contaminated system, but the hardness is not improved thereby. A factor contributing to soft coatings, even under adequate heating conditions, is the deposition of 'slow fluoride' on the glass as an undercoat. By the use of this term we indicate molecular rays, the components of which have been slowed down by collision (*a*) at the walls of the chamber, (*b*) with other molecules in space, (*c*) by energy absorption in the molten material of the fluoride source, or (*d*) by low-temperature evaporation. Such molecular rays, it is safe to assume, impinge on the glass surface at low velocity. As an undercoat they give rise to films having poor adhesion to the surface no

matter what the deposition velocity of the molecules constituting the outer layers may be. Conditions (*a*) and (*b*) can be avoided by properly placed shields and by fast pumping; conditions (*c*) and (*d*) are improved by the use of a radiant heater source in preference to a boat.

Closely associated with the foregoing phenomena is the trouble experienced when coating optics on two surfaces. We had noticed that it was difficult to secure a really hard coating on the second side of two-surface optics. The effect was investigated by covering one half of the rear surface of a flat specimen with a cover glass. The front surface was then coated in a normal manner, after which the specimen was turned over and coated on the second side without the cover. Interference colour showed the presence of a thicker layer on that portion of the second surface left unprotected. Moreover, when the eraser test was applied across the line dividing the two halves, hairlining started abruptly at the exposed portion, thus indicating a softer coat. To make sure that the extra deposit was not caused by the heaters (behind the holding fixture), the same experiment was performed with the half-covered side facing the source. The latter was baffled with a cover plate and run for the normal length of time. Next the cover-glass was removed from the specimen and a coating applied in the usual way. The results were identical with the first experiment. Even low-temperature degassing of the source with baffle in position was found to deposit a noticeable undercoat. We surmise that the undercoating observed in the foregoing experiments was a deposit of 'slow fluoride' which reaches the glass by successive collisions rather than direct evaporation from the source. The installation of faster pumps, namely, Distillation Products, Inc.—MC 500, and the development of a special pellet source, which requires no degassing, has practically eliminated trouble due to secondary coating.

It is imperative to avoid the formation of magnesium oxide by excessive muffling or similar treatment in the preparation of pure magnesium fluoride; otherwise a magnesium oxide 'skin', which has a higher melting point than the magnesium fluoride, will form during evaporation and completely cover the surface of the material. It is this layer which causes 'spatter' and consequent pitting of the optics to be filmed.

It might be of interest to mention that with the pellet source and faster pumps, a complete coating cycle from load to unload has been reduced to twenty minutes.

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[1] Bannon J., *Nature*, **157**, 446 (1946).

Molecular Rotation in Keratin

IT has been shown by Fricke and others[1,2] that the dielectric constant of gelatin-water systems may rise to abnormally large values as the water content is increased to about 50 per cent, with a consequent increase in the dielectric dispersion. They suggest that these phenomena may be either due to rotation of dipole ion groups present in gelatin which have been loosened by the sorbed water, or alternatively to the outer layers of less firmly bound water, in excess of the monolayer, which by concerted rotation exhibit 'ferro-electric' properties.

Recent work in these laboratories has shown that such abnormal phenomena are apparent in the case of the sorption of polar substances such as water, formic acid, and methyl alcohol by horn keratin. Moreover, even in the case of water where the mol fraction of the absorbate is greatest for a given mass absorbed, Cassie's[3] values show that there is insufficient water present in excess of the monolayer to allow the formation of groups of preferentially orientated water molecules in reasonable numbers, even for water contents so high as 20 per cent.

If the increase in dielectric constant were a function of the absorbate only, one should expect some correlation between the increase in

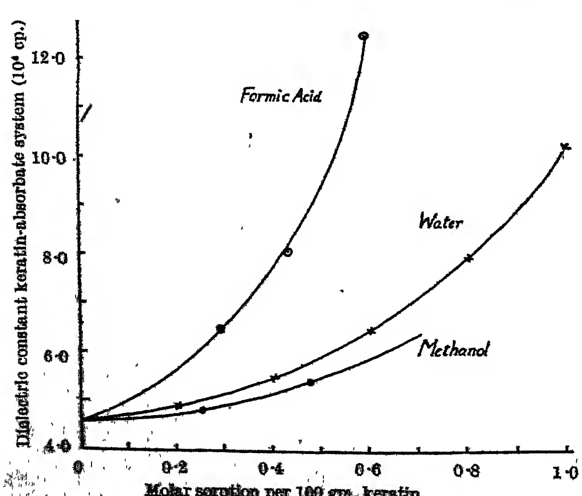

Fig. 1

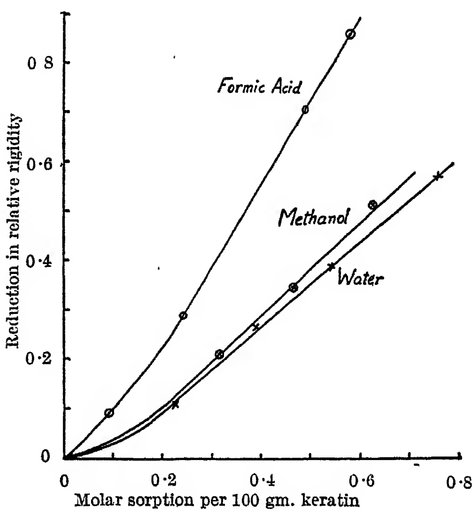

Fig. 2

dielectric constant and the dipole moment of the absorbate, assuming the increase to be due chiefly to the mobile fraction of the absorbate. Fig. 1 shows that this is not true for all three cases investigated. For a given mol fraction absorbed, formic acid, with a dipole moment of about 1·2 E.S.U., produces a much greater increase in dielectric constant of the keratin sorbate system than either water (dipole moment 1·85 E.S.U.) or methyl alcohol (dipole moment 1·7 E.S.U.).

Fricke and his collaborators point out the connexion between the dielectric dispersion and the mechanical properties of the gelatin-water system; namely, factors which increase the dispersion give rise to increased elasticity of the gelatin. Experiment shows this to be also true for keratin. The modulus of rigidity of a wool fibre was determined by the method of torsional oscillation[4] for increasing mol fractions of absorbate, using water, formic acid, and methyl alcohol (Fig. 2). Swelling corrections were obtained from A. T. King's[5] results for a wool-water system, assuming similar relations to hold for the other absorbates; any errors involved should not affect the general trend of the results.

It is seen that methyl alcohol and water have roughly the same effect on both the rigidity and dielectric constant of keratin, while formic acid exhibits a greatly enhanced effect in either instance for equal molar sorption. Such evidence supports the hypothesis that increased rotation of polar groups in the polypeptide chains is responsible for both effects.

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Elements Occupying the Position of No. 61

A RECENT investigation has resulted in the finding of actinium[1] accumulated between neodymium and samarium magnesium nitrates after fractional crystallization; that is, between elements Nos. 60 and 62. I have carried out a separation of the above two salts, but with the addition and aid of the isomorphous bismuth magnesium nitrate. This last, using as solvent the weakest possible nitric acid, is intermediate in solubility between neodymium and samarium, and not appreciably more soluble than samarium, as when stronger acid is used. It was thus possible to reduce the neodymium – samarium intermediates from several kilograms of oxides almost to vanishing point. The products were examined by Drs. Collie and Roaf in the Clarendon Laboratory, Oxford, in 1937. The now well-established radioactivity of samarium was confirmed, but the small intermediate fractions were found to possess a stronger activity. This was eventually traced to thorium through determination of the half-life of the emanation.

Any substance possessing a slight solubility in the double magnesium nitrate solution, but tending to accumulate at the head, will also accumulate at a point where the solution suddenly becomes weaker. The saturated neodymium solution has only 40 per cent of the strength of the saturated samarium solution, so the ascending impurity is held up at the junction. Gross quantities of thorium, however, are eliminated at the tail.

Sometimes yttrium will also be found in a position between neodymium and samarium. Though its ionic radius is close to that of holmium, in atomic volume as determined from the metal density[2] it is slightly less than neodymium and would be greater than samarium if the decrement between neodymium and samarium was normal. Actually, however, samarium has an abnormally large atomic volume, a peculiarity which it shares with the other two lanthanates

having bivalent properties. In the solubility of the ferricyanide[3] and in several basic precipitation processes[4], yttrium is intermediate between neodymium and samarium. No abnormalities associated with bivalency are observed in these cases. In the atomic state, yttrium appears to be interpolated six places earlier, that is, larger, in the lanthanide series than when in the ionic form. Its electron density is lower, and the three additional electrons cause a greater proportional increase in size than in the lanthanide series.

The position which should be occupied by element No. 61 in the rare-earth series appears to be capable of being filled in various circumstances by actinium, thorium, bismuth or yttrium.

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June 27.

[1] Takvorian, *Ann. chim.*, (xi), **20**, 113 (1945).
[2] Klemm and Bommer, *Z. anorg. Chem.*, **231**, 138 (1937).
[3] Prandtl and Mohr, *Z. anorg. Chem.*, **236**, 243; **237**, 160 (1938).
[4] See Moeller and Kremers, *Chem. Rev.*, **37**, 130 (1945).

Supersonic Cries of Bats

Dr. Griffin has recently published[1] some further observations on the cries of bats, which are of great interest. He demonstrates clearly that the pulse of sound is often extremely short, having a duration which usually does not exceed 2·3 milliseconds. He also finds that the frequency of the supersonic tone alters during the pulse, having a frequency, for example, of 80 kc. at the beginning, dropping to less than 50 kc. at the end. This drop of somewhat less than an octave seems to be typical. The records which Dr. Griffin has obtained are very convincing on both these points.

What are not so convincing are his arguments with regard to the mode of production of the supersonic tone. In my paper I advanced the hypothesis that this is emitted through the snout, rather than through the mouth. I also suggested that the buzz and click originated in different structures from those responsible for the production of the supersonic tone. With both these suggestions Dr. Griffin disagrees. He thinks emission takes place through the mouth, and that the three sounds just mentioned are all produced by the same structure.

With regard to the first point: he says that plugging the anterior nares of a bat does not prevent the production of the supersonic tone; secondly, when bats are feeding, the supersonic tone is interrupted; further, if the mouth is sealed with collodion, bats do not fly until they have scraped an opening into the mouth cavity; lastly, covering the nostrils causes an increase in the audible component of a bat's cry.

My comments on the above are as follows: Spallanzani found that plugging the nostrils of a bat caused acute respiratory embarrassment. Why was it that Dr. Griffin did not find the same thing? With regard to the second point, it seems to me much more likely that the interruption during feeding is not produced by the closure of the mouth cavity, but by the act of swallowing. No mammal can both swallow and speak at the same time, because the food-stream has to pass across the ducts which convey the air-stream from the nose to the larynx. Thirdly, since bats do not fly for fun, but to collect food, it would be quite useless for a bat to fly while its lips are sealed in such a manner that food cannot gain access to the mouth cavity. Lastly, it seems to me to be likely that the increase in the audible component of the bat's cry, on sealing the nose, is due to the increased efforts which are necessary in order to force a sufficiently intense supersonic tone for localizing purposes through the mouth cavity.

With regard to the click and buzz which accompany the supersonic tone, Dr. Griffin advances the following arguments: (1) there is no evidence in his records of the presence of a low frequency component; (2) whispered sounds which had approximately the same loudness as the bat's audible click gave cathode ray deflexions which were easily visible; (3) the envelope of the pulse is rather abruptly cut off towards its end.

These facts prove, in Dr. Griffin's opinion, that the audible click results from the abrupt starting or stopping of the pulse. In this case also, I have a feeling that Dr. Griffin is misinterpreting the facts. (1) With regard to the first point, the presence or absence of evidence depends entirely on the properties of the amplifier used by Dr. Griffin. It might be that such low-frequency components, even if present, do not adequately disclose themselves, because of amplifier defects. (2) The fact that whispered sounds produce a visible record does not throw any light on this point because, as is well known, such sounds consist essentially of quite high-pitched components. (3) With regard to the envelope of the pulse, it is true that there are some differences between their beginnings and endings. In Fig. 1 they are about equally abrupt; in Fig. 2 the beginning is much more abrupt than the end; in Fig. 3 the end is much more abrupt than the beginning; in Fig. 4 it is a little difficult to draw any exact conclusion, so that, to my mind, the evidence is far from clear on this point.

If the tympanic membrane and ossicles of a bat act together as a rectifier for the incoming sound, then on the analogy of electricity, one would expect a pulsating direct-current component to be present when the supersonic tone is falling on the ear. This should be appreciated as a musical tone, the frequency of which would depend on the number of pulses per second of the supersonic tone. It is not suggested that this musical tone would be a pure one: on the contrary, Dr. Griffin's records demonstrate clearly that some over-tones would be present. But a musical tone accompanied by over-tones is not at all what a human listener perceives, for Galambos and Griffin describe it as a buzz when it is recurring time after time and as a click when it takes place singly. Dijkgraaf describes the sound as a rattling one. These descriptions do not seem to me to tally at all with what I would have expected from audio-frequency components produced by the incidence of the supersonic tone on the ear. Is it not much more likely that the buzz, click or rattle is produced quite separately from the supersonic tone, that is, by a structure different from the vocal cords? In my article in *Nature*, I suggested the false cords as the originators of these noises; it is possible that the laryngeal orifice is used instead. One or other of these structures being shut, the air pressure in the lungs is raised by muscular contraction, the orifice in question is then suddenly opened, causing a burst of high-pressure air to pass between the vocal cords; at first the pressure is high and the vibrations rapid, but as the pressure drops the frequency drops at the same time.

There are two further points in favour of the view that the supersonic tone is emitted through the nose. It was pointed out to me that the nasal cavities of a bat are almost in a straight line with its vocal cords, thus supersonic tones would have an uninterrupted course out through the anterior nares. Secondly, that the snout, modified into a flat plate as it is in some bats, would be a much more efficient emitting surface for a supersonic tone than would the mouth, which contains the soft structure of variable shape, namely, the tongue.

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[1] *Nature*, **153**, 46 (1946).

Chaos, International and Inter-molecular

Statistics of wars have been collected from the whole world for the 120 years beginning with A.D. 1820. Attention was directed to the number of nations, or other large belligerent groups, on each side of any war. Accordingly, wars were classified as 1 group versus 1 group, or as 2 versus 1, or as 2 versus 2, and in general as r versus s. The number of wars of each of these types was counted. The result was a fairly regular statistical distribution, having a peculiar shape. Among a total of 91 wars there were 42 of the type '1 versus 1', 24 of the type '2 versus 1', and not more than five wars of any one more complicated type. The simplest type of encounter was the most frequent.

In a gas at N.T.P. encounters of two molecules are much more frequent than encounters of three, as is well known from chemical experiments. This resemblance between a gas and the political world suggested a theory for each of them. The frequency of an encounter, of specified type, can be regarded, after the manner of Bernoulli, as the product of the following three factors. (i) The number of mutually exclusive encounters of that type. (ii) The probability that the opponents encounter one another. In this factor the probabilities for the separate pairs of opponents combine by multiplication. That is the chief reason why, in the chaos, complicated encounters are rarer than simple encounters. (iii) The probability that all the other nations, or molecules, keep out of the encounter. Strange to say, this third factor escaped the attention of the authors of the classical theory of gases. Consequently at high densities a proportion of the encounters which Guldberg, Waage and their modern successors have regarded as binary, are now shown to be ternary. How this affects the chemistry depends on whether, for molecules, 'two can be company but three none'.

Although three factors of the aforesaid sort are likely to appear in the theory of any chaos, yet their particular forms depend on circumstances; so that many varieties of chaos are conceivable. In the political world there were restrictions depending on geography and on sea-power. When they had been formulated, another effect became conspicuous, namely, the infectiousness of local fighting.

The justifications of the foregoing brief statements have been accepted for publication, those concerning gases in the *Proceedings of the Royal Society*, and those concerning the political world in the *Journal of the Royal Statistical Society*.

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Robert Hooke's Letter of December 9, 1679, to Isaac Newton

The correspondence between Hooke and Newton in November and December 1679 dealing with experiments on falling bodies led to bitterness and to the final break between them. But "it must be looked upon as one of the greatest and most fortunate events, since it was the direct cause of the composition of the Principia".

When W. W. Rouse Ball published this Hooke–Newton correspondence in 1893, two of the letters were missing. Jean Pelseneer published one which had been found and which is now in the British Museum ("Une lettre inedite de Newton", *Isis*, **12**; 1929). Hooke's letter of December 9, 1679, the rough contents of which were known from the minutes of the meeting of the Royal Society on December 11, the last missing link in this correspondence, has just been rediscovered by me and is in my possession. It is the letter of which Pemberton says that it "put him [Newton] on inquiring what was the real figure in which a body, let fall from a high place, descends, taking the motion of the earth round its axis into consideration", and which caused Brewster ("Life of Newton", 1855, I, p. 291) to add "this gave occasion to his resuming his former thoughts".

The letter covers two folio pages with diagrams; it was at the end of the last century in the collection of Alfred Morrison (1821–97), the well-known collector. It is not described in the thirteen-volume catalogue of the "Morrison Collection of Autographs" (1883–96), nor was its importance recognized by later owners after it was sold on April 19, 1918, at Sotheby's. The publication of the full text is better left to other hands.

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ROYAL SOCIETY EMPIRE SCIENTIFIC CONFERENCE

Recommendations

AT the Royal Society Empire Scientific Conference during June 17–July 8, discussions took place on a number of topics, and recommendations representing interpretations of the general views of delegates and guests were framed by the steering groups for each of the discussions. We print the recommendations below.

Outstanding Problems in Agricultural Science in the British Empire

1. A Conference of soil surveyors and pedologists should be set up to consider the development of soil surveys in general and to co-ordinate methods of soil classification.

2. Work is required on the structure of clays, of humus, and of the clay-humus complex, requiring advance of technique in studying finely divided material.

3. Work is required on the ion-water atmosphere surrounding colloidal bodies, including living organisms, root hair, and on the structure and binding force of the water. This should include a study of reaction in interpenetrating atmospheres.

(2 and 3 together should throw much light on the agricultural problems of soil structures, aggregation and stability to alternations of wetting and drying, anti-erosion properties, availability and fixation of plant nutrients and inhibition of uptake of one plant nutrient in the presence of another, for example, Ca : K balance.)

4. Further study is required in the subject of soil microbiology. This should include the relation of soil micro-organisms to soil organic matter, the availability of inorganic plant nutrients and plant pathology as well as such taxonomic work as may be necessary.

5. It is recommended that efforts should be made to evolve both methods and apparatus for studying the nature of the stress-strain relationships in soil in particular relation to cultivations.

6. Special study is required of the developmental and physiological action of the root in relation to its environment. This involves the study of (*a*) the water relations, (*b*) the mineral relations of the root as well as root secretions and excretions.

7. Physiological development of plants in relation to environment, especially temperature and light (intensity, duration and quality and therefore artificial and natural 'shade') should be studied.

8. Investigations are required on the following problems: (*a*) quantitative inheritance; (*b*) incompatibility and sterility of wide crosses; (*c*) the induction of polyploids and the possibility of inducing desirable mutations; (*d*) breeding methods.

9. Investigations are needed on the epidemiology of fungal, insect and virus organisms and on pathogenic species in relation to strain specialization.

10. Further investigation should be made into methods of control of fungal, insect and virus attacks, especially the possibility of breeding for disease resistance and the nature of such resistance.

11. Climatic surveys, both regional and local, are accepted as a pre-requisite to the investigation of agricultural problems. There should be provided throughout the Commonwealth and Empire a series of meteorological stations measuring daily rainfall, free water surface evaporation, relative humidity, day and night temperature of the shaded and unshaded atmosphere and the quality and intensity of daylight.

12. Both reconnaissance and detailed soil surveys should be available as a basis for ecological and physiological investigations of the field problems and concerning agriculture.

13. Ecological studies of the natural vegetation should form part of regional surveys designed to afford an integrated pattern of climatic and soil relationships. For this reason, vegetational surveys need, whenever possible, to accompany soil surveys.

14. Animal physiology on a general basis and including all the chief domestic animals should be specifically studied. This is the need basic to research on nearly all kinds of practical livestock problems, including those of pathology. The study (biochemical and microbiological) of ruminant digestion is a good example.

15. There is a dearth of men with ample knowledge of domestic animal physiology. Steps should be taken to encourage their training and their subsequent employment.

16. More knowledge is required of metabolism and enzyme systems of spermatozoa and of ova.

All through the session there was insistence on the manifest dependence of agricultural science on further developments in the basic sciences.

Physiological and Psychological Factors Affecting Human Life under Tropical Conditions and in Industry

General. The Conference surveyed certain of the results obtained during the War in the laboratories of the Medical Research Council at Cambridge and London, and in the Department of Physiology, University of Queensland. It was agreed that much of this work had a general application to many countries of the Empire. It was agreed further that facilities for developing this work, both in laboratories in the 'field' and in suitably equipped centres in the United Kingdom and Dominions, were desirable.

Special recommendations. 1. Physiological and psychological research carried out under artificial conditions for war-time purposes needs to be extended to actual conditions in the tropics and to industries in which high temperatures are encountered. This would require the establishment at suitable centres (for example, in Africa and in the Far East) of well-equipped laboratories. These should work in close contact with similar laboratories in the United Kingdom and Australia, in which the more basic research should be carried out.

2. Research on output in industry in the tropics needs to be done as data are practically non-existent. Investigation is required also into the habitability problems of clothing, housing and transport.

3. Attention is directed to the need for improvement of instruments for the study of climatic factors.

4. An authoritative guide on standards for building (domestic and industrial) in the tropics on the lines of the reports of the Building Research Station of the Department of Scientific and Industrial Research is desirable.

5. War-time standards of ventilating practice in the Services need to be reviewed in relation to civilian and industrial conditions in the tropics. A revision of existing scales of warmth and comfort is urgently required.

6. There is a definite need for co-ordination within the Commonwealth. This should take the form of exchange both of workers and of information. It is suggested that a co-ordinating Empire Committee on Human Climatology should be set up. This would include workers in physiology, psychology, industrial hygiene, the related aspects of nutrition and also representatives from the allied field of tropical animal physiology.

7. It is strongly recommended that provision be made for a number of research fellowships for Colonial medical graduates, to enable them to carry out research in climatological laboratories.

8. The participation, by the Commonwealth countries concerned, in a co-operative study of air-conditioning and the consequent engineering developments, is recommended.

Etiology and Control of Infectious and Transmissible Diseases

General. 1. The Conference, having regard to the present state of knowledge of the ecology of infectious diseases, feels that there are grave dangers of spread from one part of the Empire to another and within certain Empire countries. Particular attention was directed to malaria, yellow fever, schistosomiasis, trypanosomiasis, plague and cholera.

2. More knowledge of the ecology of infectious diseases, their arthropod vectors, their reservoir hosts and the reasons for the persistence of infection in localized endemic areas is needed. The attention of universities and other authorities should be invited to the need in many parts of the Empire for ecologists and entomologists, both medical and non-medical.

Special recommendations. 1. That an international organisation should be established under the United Nations Organisation to prevent the spread of diseases from endemic to non-endemic areas. Such an organisation would: (*a*) control vaccination and inoculation in connexion with diseases to which these or other such precautions may be held to be applicable; (*b*) ensure the freedom of aeroplanes, aerodromes, ships and other facilities for travel between different countries, from insects and other media of infection; (*c*) secure uniformity in regulations regarding certificates required by travellers between different countries; (*d*) devise such methods of administration as would avoid vexations and unnecessary impediments to the movement of travellers or goods.

The Conference notes that existing regulations at airports and other transit centres are unsatisfactory owing to a shortage of trained sanitary inspectors and other medical personnel. It would direct attention to the availability of a substantial pool of junior personnel suitable for recruitment into the required sanitary service, among ex-Service men and women, particularly in India and the Colonies.

2. For the prevention of the spread of certain diseases from endemic to non-endemic areas within particular countries, the Conference urges that local and permanent organisations are required for containing and controlling the diseases in the endemic areas. Particular reference is made to cholera and plague.

The Science of Nutrition with Particular Reference to the Special Problems of the Empire, including the Nutritional Status of the Indigenous Peoples of the Colonies

Preamble. The Conference recognizes that the improvement of the nutritional status of the peoples of the Commonwealth is a part of general social and economic policy in the territories concerned. It urges the necessity for developing at all levels of Colonial government a proper awareness of the nutritional needs of the indigenous peoples.

The Conference strongly supports the need for integrating the efforts of producer, consumer, technical and administrative personnel in effecting improvements in nutrition. In this connexion the suggestion put forward at the first session of the Conference of the Food and Agriculture Organisation for the achievement of such integration is welcomed.

The Conference agreed upon the evidence of malnutrition in the Empire, both as to quantity and quality, and urges that measures should be applied immediately for the improvement of the present position.

Special recommendations. 1. Immediate therapy of vitamin-deficiency diseases, particularly vitamin B_1 for beriberi in Malaya and Hong Kong, iodine in goitrous areas in Nigeria, calcium and vitamin D in areas where rickets occurs in the Gold Coast, iron where anæmia is common, especially in British Guiana.

2. The introduction into the diet of indigenous peoples of nutritional supplements, such as iodine, calcium, iron.

3. Improved methods of storing, processing and distributing foodstuffs, such as better methods of milling wheat and maize, the parboiling of rice, the drying of fish, fruit and vegetables. The Conference urges the need for more food technologists in this connexion.

4. Increased production of the 'protective foods' through: (*a*) the control of livestock diseases; improved animal husbandry and animal breeding, especially of local strains, with the object both of increasing the productivity of the native pastoralist's herds and of developing dairy types suited for use in native mixed farming areas; (*b*) increased and improved fishing operations with the following general objectives: (i) fishery exploration and fish catching (fishery engineering); (ii) fish processing and technology; (iii) fishery biology and hydrography; (iv) development of great lake fisheries together with fish culture in fresh and brackish waters.

5. Increased food production generally by: (*a*) the greater use of fertilizers; (*b*) the extension of plant breeding. More plant surveys and an increase in the number of trained plant breeders are urgently required for this purpose, particularly in the African Continent.

Modern Methods of Mapping and Exploration by Air

The Conference agreed that the use of radar would much reduce the time required for the making of maps. In view of the importance of completing the topographical mapping of various parts of the Commonwealth for the purpose of economic development, the Conference put forward the following recommendations:

1. Research and development in radar and photographic equipment and techniques in air survey

should be vigorously pursued, if the full scientific and economic advantages of these methods are to be obtained in all parts of the Commonwealth.

2. The appropriate authorities should be approached with the view of increasing the number of persons trained to conduct further research in these subjects.

Scientific Information Services

General. The Conference invites the Royal Society at an early date to convene a conference of the libraries, societies and institutions responsible for abstracting and information services, in order to examine the possibility of improvement in existing methods of collection, indexing and distribution of scientific literature, and for the extension of existing abstracting services. The Conference would pay particular regard to the cost of such services and to the need for funds from Government sources for their support.

In the proposed conference: (1) Representatives of the appropriate authorities in the Dominions, India and the Colonies should be included, together with observers from the United States. (2) The interests of scientific men as users of scientific information should be especially considered. (3) Consideration should be given to the abstracting of Dominion journals locally, for transmission to the main abstracting bodies in the United Kingdom.

Special recommendations. 1. Consideration should be given to the establishment of a network of information services throughout the Dominions. Such a network would provide central focal points and for a two-way transmission of matter (either direct or through existing local centres adapted for the purpose).

2. In view of the need of the scientific worker for possession of individual scientific papers on his own subject, the possibility of the publication, classification and distribution of papers in separate form or as reprints should be considered.

3. The issue of occasional reviews of special branches of science, both for the specialist and for the general scientific reader, is considered desirable as a supplement to other forms of publication.

4. The extended provision of micro-film and other forms of documentary reproduction is considered important for the rapid transfer of information throughout the Commonwealth. An economic service for the purpose requires centres in the United Kingdom and in each of the Dominions.

5. The Conference recognizes that the qualifications of staff in scientific information services and special libraries call for special training and selection, and recommends the provision of facilities for increasing the number of properly trained staff.

Interchange of Scientific Workers throughout the Empire, and the Future of War-time Scientific Liaison Offices

The Conference agrees that interchange of scientific staffs, both of universities and research institutions, is of vital importance to the maintenance and development of scientific research within the Commonwealth and Empire.

1. To promote such interchange the Conference strongly urges upon all the responsible authorities the urgent need for: (i) adequate provision by universities and research institutions to enable the senior and junior scientific staffs to take periodical leave for overseas visits, both short- and long-term; (ii) the raising of staff complements to a level sufficient to afford individuals adequate time for research and for study or for special leave without thereby placing additional burdens on their colleagues; (iii) provision of the largest practicable number of travelling scholarships for post-graduate work (see also 2 (ii) below); (iv) a system of adequate financial provision for travelling and subsistence allowances to avoid loss to the individual due to differences in living costs in different countries; this is to apply both for members of university staffs and for holders of travelling scholarships; (v) the provision of resources to enable the invitation of scientific workers from overseas for short periods to advise or for collaboration in specific research projects; (vi) the exemption of all travelling scholarships and allowances from income tax either in the country of origin or of reception.

2. To the same ends the Conference further recommends: (i) an official policy for continuance and development of a system of Commonwealth liaison offices as being an essential part of the machinery for facilitating interchange of scientific workers and activities connected therewith, and directs that the attention of the Official Conference be invited to the matter; (ii) urges the need for the central compilation and publication of a list of scholarship facilities existing within the Commonwealth and proposes that the task be entrusted to whatever organisation may be employed for centralizing scientific information services; (iii) invites the attention of the Official Conference to the need for the adoption of a uniform superannuation scheme for the Commonwealth to facilitate transfers without prejudice to such rights; (iv) notes with anxiety the serious handicap to interchange caused by the high cost of sea and air transport, and invites the Royal Society to initiate action with the appropriate organisations to remedy the position.

Empire Co-operation in the Scientific Field with Existing and Projected International Organisations

1. The Conference recommends that the delegations should advise their Governments to adhere to each of the international scientific unions, to the International Council of Scientific Unions and to other recognized international scientific organisations.

2. The Conference recommends that scientific correspondents be appointed in Colonial territories to establish and maintain direct contact in scientific matters with the operational agencies of the United Nations and with other recognized international bodies.

3. The Conference would heartily welcome a policy on the part of the United Nations and its operating agencies to make the utmost use of all scientific bodies which are doing valuable work of an international scientific character and would stress the importance of preserving the independence of such bodies and of leaving the control of their activities to scientific men.

4. The Conference recommends that each delegation should advise its Government and the established scientific institutions of its country to collaborate closely with any organisation of the United Nations concerned with the promotion of science and its applications.

Standards of Measurement

1. (*a*) It is considered highly desirable that early steps should be taken to eliminate the slight difference in the values of the yard and pound at present in use in the Commonwealth and in the United States of America.

(*b*) It is recommended that discussions should be pursued with the appropriate authorities in the United States with the view of reaching mutual agreement on this question (as a basis of recommendations to Commonwealth authorities) and that the Director of the National Physical Laboratory, Teddington, should act in this matter on behalf of National Laboratories in the Commonwealth.

The Conference suggests that: (i) the reformed units should be precisely related to the corresponding metric units; (ii) tentative values for conversion factors should be as follows: 1 yard = 0·9144 metre exactly, or 1 inch = 25·4 mm.; 1 lb. = 0·453 592 37 kgm. or 0·453 592 3 kgm.

2. The Conference advocates the adoption of the metric system in all fields of science. Examples of subjects in which an improvement in this respect is desirable are aeronautics and pharmaceutical science.

3. If text-books and scientific data or memoirs are expressed in systems other than the metric, conversion factors or the metric equivalent should be included.

4. The Dominions and India should participate in the organisation of the Convention du Mètre.

5. There should be meetings at suitable intervals of representatives of the Commonwealth National Laboratories to consider: (*a*) the maintenance of uniformity of standards of measurements; (*b*) general programmes of research in regard to fundamental scientific standards. The National Physical Laboratory in Great Britain should act as the co-ordinating body. The Conference emphasized the importance of mobility of workers between the various laboratories.

6. Within the Commonwealth there should be organised a service of radio transmissions at standard frequencies which, together with those of the United States, would suffice to meet the needs of the Empire.

7. The United Nations Standards Organisation be asked to give consideration to the question of nomenclature and symbols at the international level, taking into account, so far as is practicable, both scientific and industrial usages.

8. The Conference records its appreciation of the advances which have been made in the international standardization of biological materials and noted with satisfaction that much of this standardization is now brought on to a physical and chemical basis.

Collection of Scientific Records and Material and Risks Involved in the Distribution of Plants, Seeds and Animals

1. Having regard to the limitations of space and scientific man-power, we recommend a policy of rationalization in respect to research collections for taxonomy. To this end the avowed scope and objective should be publicly stated by each institution, especially as to the particular groups for which it accepts responsibility of intensive representation.

2. When new species are described, replicates should, where possible, be provided for major cosmopolitan collections and for those institutions where the group concerned is intensively studied. For unique specimens, microfilms, casts, etc., should be similarly provided.

3. Increased provision be made for the training of taxonomists and that an increased number of taxonomic posts be created.

4. Better facilities be provided for the collection of living material, for its reception when collected, and its subsequent maintenance.

5. To ensure early action and continuing attention for varietal collections of economic species, for genetic and breeding purposes, one organisation in the Commonwealth should be specifically entrusted with the essential central co-ordination.

6. Adequate quarantine measures should be taken respecting new introductions to ensure their supervision before release and competent diagnosticians be available. Such quarantine measures to be supplemented by a good intelligence service.

7. Information regarding the geographical distribution of pests and diseases should be made readily available.

8. Steps should be taken to preserve native breeds of livestock.

Land Utilization and Conservation throughout the Empire

In view of the gravity of the situation caused by the loss of and damage to the soil in many parts of the Commonwealth, the Conference attaches great importance to the carrying out of the following recommendations, with the help of trained agricultural scientists: (*a*) erosion surveys; (*b*) soil surveys; (*c*) investigations relating to the maintenance and improvement of soil fertility.

In addition to the above investigations, the Conference urges the importance of surveys to determine the present pattern of and trends in land use, as a basis for the maintenance of soil fertility.

In view of the similarity existing between problems of soil conservation in different parts of the Commonwealth, the Conference would emphasize the importance of a continuous interchange of information and the need for periodic conferences of specialist officers engaged upon problems of soil fertility, erosion and land utilization.

A Co-ordinated Survey of the Mineral Resources of the Commonwealth

General. The Conference reviewed carefully the position regarding the mineral resources of the Commonwealth in relation to the serious present and threatened further shortage of many important key minerals; and agreed that a much increased Empire effort is required in all aspects of geology, geophysics, mineralogy, process metallurgy and in the compilation of reliable data on which estimates of present and future supplies of minerals may be made.

Special recommendations. 1. That a Commonwealth organisation be established with headquarters in Great Britain to include the following functions, some of which are performed already by the Imperial Institute: (*a*) To act as a clearing house for information, statistical and general, on the scientific and economic aspects of the mineral resources and mineral production metallurgical industries of the Empire. (*b*) To institute, in concord with the various Governments of the Commonwealth, standard methods of recording figures of production, trade and resources in mineral and metallurgical products. (*c*) To promote the exchange of information regarding the estimation of mineral reserves and/or to publish estimates at suitable intervals. (*d*) To provide an

information service dealing with publications concerning all branches of geology, mineralogy, palæontology, geochemistry, applied geophysics, ore-dressing and production metallurgy. (e) To refer to suitable specialist institutions for advice or investigation, mineral problems and specimens, for the study of which facilities may not be available at the time in most parts of the United Kingdom, Dominions, or Colonies; and to advise on the extension of existing, or establishment of new, institutions as may from time to time be considered necessary to meet the requirements in these respects of the Commonwealth.

2. That systematic geological survey work being the foundation of all progress in the mineral industries, in future much stronger geological organisations are essential for work in all parts of the Commonwealth.

3. That attention be given to proposals to assist established British journals of geology, mineralogy and palæontology, etc.

The Conference reviewed with approval the accompanying summary of the essential functions of a geological survey and agreed that anything short of this programme would generally prove to be an uneconomical investment of public funds.

Appendix. Essential Functions of a Geological Survey

Official geological surveys should be maintained in sufficient strength to permit of:

(*a*) The development of the general geological map, which will become the guide for all prospecting activities, official and private, as well as for operations regarding water supply and engineering projects.

(*b*) The preparation of a geological map by stratigraphical geologists is not possible without the constant reference of questions to specialists in palæontology, petrology, mineralogy and geophysics.

(*c*) For the development of the mineral resources of a country to the best advantage, it is important for a geological survey department to be familiar with the statistics of production, imports and exports. From the figures of such returns the department can advise its Government to direct its policy to the encouragement of industries based on raw mineral supplies, for it is obviously uneconomical to export raw minerals which might be smelted or otherwise processed near their sources, and equally uneconomical to import materials and articles which might be manufactured from minerals of domestic origin.

(*d*) It is essential to build up at the headquarters of a survey a reference library and a collection of reference specimens. It is equally important to maintain publications in recognized form, through the distribution of which geological officers will get the criticism as well as the appreciation of outside scientific and technical communities.

(*e*) The activities of a geological survey department should be purely advisory; but as the full list of specialists and equipment required is generally beyond the capacity of smaller States and Colonies to maintain, it is desirable to federate for such advisory functions suitable groups geographically and politically related to one another.

Natural Products of the Empire and the Chemical Industries that are or might be Based on them

In view of the varied nature of the natural products of the Commonwealth, their wide geographical dispersal and the diverse and often inadequate facilities in staff and equipment which may be available locally for their investigation, the Conference makes the following recommendations:

1. That a standing central committee, including representatives of the United Kingdom, the Dominions, India and the Colonies, should be set up to advise upon policy for the co-ordination of research, both scientific and economic, into the natural products of the Commonwealth. Such advice upon their own particular problems would be made available to all Commonwealth countries with the minimum of delay.

2. The Conference, while recognizing the desirability of centralizing research upon problems common to many parts of the Commonwealth, supports very strongly the view that research upon problems of more local interest should be co-ordinated within regions. It is anticipated that this would lead to increased efficiency and economy in man-power. The Conference regards advice upon the concentration or regionalization of the research in question as an important function of the central committee.

Post-War Needs in Fundamental Research

The Conference wishes to direct the attention of all concerned with the guidance of fundamental scientific research to the Royal Society's "Report on the Needs of Research in Fundamental Science after the War". It would also invite attention to the report on scientific man-power recently issued by the Government of the United Kingdom. The discussion at the Conference, which was of necessity limited in scope, revealed a particular shortage in the Commonwealth of scientific workers in such fields as taxonomy, genetics and microbiology.

1. The Conference is of the opinion that in each country of the Commonwealth the mechanism for guiding long-term research in fundamental science should be reviewed, in order to foster fertile research work in all important subjects. The systems for advice and financial assistance in this connexion should be studied carefully.

2. The needs of the future will require a great increase in the number of scientific workers, and it is considered important that plans for extending fundamental research in any field should be supported by measures designed to increase the number of trained scientific men able to carry out such plans.

3. In order to secure the proper flow of young scientific workers from educational establishments, it is considered of importance that the educational system of each country should be harnessed so far as may be necessary to this particular long-term need.

Africa as a Regional Area for Fundamental Scientific Research

1. The Conference considers that there is a growing need for the development of long-term fundamental research dealing with African problems on a regional, as distinct from a territorial, basis.

2. To meet this need there should be formed at an early date a Commonwealth African Research Committee with the following terms of reference: (*a*) to examine and put forward proposals for the centralization of fundamental research in African problems on a regional basis; (*b*) to plan such developments ahead so as to ensure the necessary financial support and the training of the specialist staffs needed; (*c*) to advise the Governments con-

cerned through the appropriate authorities on matters of regional development and co-operation in fundamental research.

3. The field of the Committee would in the main cover activities south of the Sahara, and foreign States with territories in this portion of Africa should be invited to be represented as observers.

Cosmic Rays

The Conference recommends that the following investigations of cosmic radiation would be of great scientific value and are also likely to have important meteorological applications.

1. Further measurements of the variation with time of the cosmic ray intensity at selected stations at sea-level and on mountains. Measurements in the southern hemisphere are of particular importance.

2. Further measurements of the variation of cosmic ray intensity with latitude and longitude by experiments in aircraft over a wide range of height.

The Conference recommends that the necessary organisation to carry out the work should be set up in the first instance on an Empire basis, but that the question of extending the organisation be raised at the next meeting of the International Union of Physics.

The Village Pond in the Rural Economy of India

The oceanographic and fisheries scientists present as delegates to the Royal Society Empire Scientific Conference request its Steering Committee to arrange that if possible a meeting be called during the period of the British Commonwealth Scientific Conference of these delegates, and other specialists available in Great Britain, to discuss methods for co-operation and co-ordination of fisheries and oceanographical research within the Commonwealth, and similar matters of common interest.

The above delegates also would appreciate any facilities which could be given for a tour to centres of fisheries research in the United Kingdom following the termination of the Official Conference.

[Action on the above recommendation was taken immediately.]

Geochemistry

Delegates attending this discussion endorse the recommendation contained in the Royal Society's Report on the needs of research in fundamental science after the War "that substantial provision should be made for quantitative spectrographic analysis of rocks, minerals and natural waters"; and further, recommend that adequate facilities in one or more institutions should be provided for like investigations (both fundamental and applied) on material which might be submitted from centres (including Colonial geological surveys and other geological organisations) within the British Empire.

Hormones

In view of the steady increase in the demand for insulin, the Conference urges that a strong recommendation be made to all the countries of the Commonwealth that every effort be made to collect, process and preserve all available pancreas. Purified insulin, which can be stored for long periods without loss of potency, will be needed on an increasing scale for the treatment of diabetes.

Fish Culture and Malaria Control

In view of the great possibilities of utilizing ponds for fish culture in various countries of the Commonwealth where malaria is prevalent, the Conference proposes that the attention of governments of countries so situated should be directed to the urgent need of integrating fish culture practice with measures for malaria control.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, July 30

BRITISH FEDERATION OF UNIVERSITY WOMEN (at Chatham House, St. James's Square, London, S.W.1), at 8 p.m.—Prof. Lise Meitner: "Atomic Energy".*

SUPERINTENDENT BACTERIOLOGIST, a SUPERINTENDENT BIOCHEMIST, PRINCIPAL SCIENTIFIC OFFICERS (3), SENIOR SCIENTIFIC OFFICERS (3), SCIENTIFIC OFFICERS (2), an EXPERIMENTAL OFFICER, and an ASSISTANT EXPERIMENTAL OFFICER, in the MICROBIOLOGICAL RESEARCH DEPARTMENT of the Ministry of Supply—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1550 (September 10).

CHAIR OF MATHEMATICS, and the CHAIR OF PHYSICS—The Registrar, University College, Leicester (September 14).

LECTURER IN BACTERIOLOGY—The Secretary, The University, Aberdeen (September 14).

ASSISTANT LECTURER and a DEMONSTRATOR IN MATHEMATICS—The Head of the Department of Mathematics, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7.

ASSISTANT MASTERS (with Honours Degree in Mathematics, Physics or Engineering, or equivalent qualifications) in H.M. Dockyard Schools—The Director, Education Department, Admiralty, London, S.W.1.

DEPUTY CHIEF CHEMIST AND JUTE TECHNOLOGIST—The Secretary, Indian Jute Mills Association Research Institute, Imperial Institute, South Kensington, London, S.W.7.

DEPUTY PRINCIPAL at the Stow College, School of Engineering—The Director of Education, 129 Bath Street, Glasgow, C.2.

JUNIOR RESEARCH WORKER—The Director, Department of Applied Economics, c/o Marshall Library, Downing Street, Cambridge.

LECTURER IN AUTOMOBILE ENGINEERING—The Registrar, North Gloucestershire Technical College, The Lypiatts, Lansdown Road, Cheltenham.

LECTURERS IN THE DEPARTMENTS OF CIVIL AND MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, APPLIED CHEMISTRY, and PHYSICS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN CHEMISTRY—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

LECTURERS IN MATHEMATICS, APPLIED MECHANICS (2), and PHYSICS, at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, Whitehall, London, S.W.1.

LECTURER IN PHARMACEUTICAL CHEMISTRY at the Cardiff Technical College—The Director of Education, City Hall, Cardiff.

LECTURER IN PHYSICS—The Head of the Physics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

LECTURERS AND DEMONSTRATORS to teach in English up to Matric. and Inter. Standards in PHYSICS, MATHEMATICS, and ENGLISH (General and Science)—The Polish Board of Technical Studies, 5 Princes Gardens, London, S.W.7.

RESEARCH ENTOMOLOGIST to study the field behaviour of wireworms in relation to baits and repellants—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

SPECIALIST (highly qualified and experienced) to take charge of the CHEMISTRY and PHYSICS DEPARTMENT—The Head Mistress, Luton High School, Luton.

TEACHERS (4, part-time) for training junior technicians in CHEMISTRY, PHYSICS, MATHEMATICS and BIOLOGY—The Establishment Officer, University College, Gower Street, London, W.C.1.

LECTURER IN PHYSICAL AND ENGINEERING METALLURGY, preferably with experience in Mechanical Treatment and Welding—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Twenty-fifth Annual Report, October 1, 1944, to September 30, 1945. Pp. 136. (London: British Electrical and Allied Industries Research Association, 1946.) [52

Royal Geographical Society. The Making of a Map: Notes on the Exhibition in the Ambulatory, 31 December 1945–5 January 1946. Prepared by Brigadier Sir Clinton Lewis. Pp. 8. (London: Royal Geographical Society, 1946.) 6*d*. [52

Ministry of Health: Department of Health for Scotland. Final Report of the Inter-Departmental Committee on Dentistry. (Cmd. 6727.) Pp. 60. (London: H.M. Stationery Office, 1946.) 1*s*. net. [62

National Central Library. 28th and 29th Annual Reports of the Executive Committee, 1943–44 and 1944–45. Pp. 26. (London: National Central Library, 1945.) [62

Ministry of Production. Third Annual Report on the Work of the Combined Raw Materials Board to January 26th, 1945. Pp. 12. (London: H.M. Stationery Office, 1945.) 2*d*. net. [62

National Institute of Agricultural Engineering. Report for the Year ending August 31st, 1945. Pp. 12. (Askham Bryan, York: National Institute of Agricultural Engineering, 1946.) 3*d*. [72

Medical Research Council. Special Report Series, No. 253: Tables of Representative Values of Foods commonly used in Tropical Countries. By B. S. Platt. Pp. 41. (London: H.M. Stationery Office, 1945.) 9*d*. net. [112

Parliamentary and Scientific Committee. Annual Report, 1945. Pp 19. (London: Parliamentary and Scientific Committee, 1946.) [112

Other Countries

Publications of the Isostatic Institute of the International Association of Geodesy. No. 7: World Maps for the Indirect Effect of the Undulations of the Geoid on Gravity Anomalies. By W. Heiskanen and Erkki Niskanen. Pp. 14. No. 8: On the Figure and Structure of the Earth. By W. Heiskanen. Pp. 46. No. 9: Gravity Formulas derived by the Aid of the Latitude and Longitude Zones. By N. Luoma. Pp. 19. No. 10: On the Structure of the Earth's Crust in the neighbourhood of the Ferghana Basin. By V. Erola. Pp. 77. No. 11: On the Isostatic Structure of the Earth's Crust in the Carpathian Countries and the related Phenomena. By L. Tanni. Pp. 100. No. 12: On the Deformation of the Earth's Crust under the Weight of a Glacial Iceload and related Phenomena. By E. Niskanen. Pp. 59. No. 13: The Gravity Anomalies on the Japanese Islands and in the Waters East of Them. By W. Heiskanen. Pp. 22. (Helsinki: International Association of Geodesy, 1941–1945.) [1'

South African Archæological Society. Handbook Series No. Method in Prehistory; an Introduction to the Discipline of Pre toric Archæology, with special reference to South African Conditi By A. J. H. Goodwin. Pp. 191. (Cape Town: South African A æological Society, 1945.) 12*s*. 6*d*. [1

Colony and Protectorate of Kenya. Forest Department Pamphlet No. 11: The Management of Cypress Plantations in Kenya. By S. H. Wimbush. Pp. 32. (Nairobi: Government Printer, 1945.) [151

Nyasaland Protectorate. Annual Report of the Forestry Department for the Year ended 31st December 1944. Pp. 12. (Zomba: Government Printer, 1945.) [151

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U.S. Department of Agriculture. Miscellaneous Publication No. 511: Classification of the Dermestidæ (Larder, Hide and Carpet Beetles) based on Larval Characters, with a Key to the North American Genera. By Bryant E. Rees. Pp. 18. Technical Bulletin No. 897: Factors affecting Curly Top Damage to Sugar Beets in Southern Idaho. By D. E. Fox, J. C. Chamberlin and J. R. Douglass. Pp. 29. Technical Bulletin No. 901: Reaction of Small-Grain Varieties to Green Bug Attack. By I. M. Atkins and R. G. Dahms. Pp. 30. (Washington, D.C.: Government Printing Office, 1943–1945.) [151

U.S. Office of Education: Federal Security Agency. Bulletin 1945, No. 10: Education in Chile. By Cameron D. Ebaugh. Pp. vii + 123. (Washington, D.C.: Government Printing Office, 1945.) 25 cents. [151

Smithsonian Institution: United States National Museum. Bulletin 186: The Birds of Northern Thailand. By H. G. Deignan. Pp. v + 616 + 9 plates. 1.25 dollars. Bulletin 187: An Annotated Checklist and Key to the Snakes of Mexico. By Hobart M. Smith and Edward H. Taylor. Pp. iv + 239. 50 cents. (Washington, D.C.: Government Printing Office, 1945.) [151

Bulletin of the American Museum of Natural History. Vol. 86, Art. 2: Notes on Pleistocene and Recent Tapirs. By George Gaylord Simpson. Pp. 33–82 + plates 5–10. (New York: American Museum of Natural History, 1945.) [151

Proceedings of the American Academy of Arts and Sciences. Vol. 74, No. 14: Records of Meetings, 1940–1941, 1941–1942, etc. Pp. 441–488. 2 dollars. Vol. 75, No. 1: Papers on Post-War Problems. Pp. 54. Vol. 75, No. 2: The Lower Permian Insects of Kansas, Part 9: The Orders Neuroptera, Raphidiodea, Caloneurodea and Protorthoptera (Probnisidæ), with additional Protodonata and Megasecoptera. By Frank M. Carpenter. Pp. 55–84. 90 cents. Vol. 75, No. 3: Some Factors in the Defense Mechanism against Reinfection with *Trypanosoma lewisi*. By Donald L. Augustine. Pp. 85–94. 35 cents. Vol. 75, No. 4: Chao Hsüeh-min's Outline of Pyrotechnics; a Contribution to the History of Fireworks. By Tenney L. Davis and Chao Yün-ts'ung. Pp. 95–108. 80 cents. Vol. 75, No. 5: New Researches on Magnetization by Rotation and the Gyromagnetic Ratios of Ferromagnetic Substances. By S. J. Barnett. Pp. 109–130. 1.35 dollars. Vol. 75, No. 6: Presidential Address, Records of Meetings, 1942–1943, 1943–1944, etc. Pp. 131–208. 1.60 dollars. Vol. 76, No. 1: The Compression of Twentyone Halogen Compounds and Eleven other Simple Substances to 100,000 kg./cm.^{2}, by P. W. Bridgman; The Compression of Sixty-one Solid Substances to 25,000 kg./cm.^{2}, determined by a New Rapid Method, by P. W. Bridgman. Pp. 24. 1 dollar. (Boston, Mass.: American Academy of Arts and Sciences, 1942–1945.) [151

U.S. Department of the Interior: Geological Survey. Bulletin 928–B: Geology and Ore Deposits of the Shafter Mining District, Presidio County, Texas. By Clyde P. Ross. (Contributions to Economic Geology, 1941–42.) Pp. iv + 45–126 + plates 6–12. 65 cents. Bulletin 931–S: Manganese Deposits in the Paymaster Mining District, Imperial County, California. By Jarvis B. Hadley. (Strategic Minerals Investigations, 1941.) Pp. iii + 459–474 + plates 75–77. 30 cents. Bulletin 935–A: Chrome Resources of Cuba. By T. P. Thayer. (Geologic Investigations in the American Republics, 1941–42.) Pp. v + 74 + 20 plates. 1 dollar. Bulletin 935–D: Tungsten Deposits, Isla de Pinos, Cuba. By Lincoln R. Page and James F. McAllister. (Geologic Investigations in the American Republics.) Pp. iv + 177–246 + plates 32–43. 1.25 dollars. Bulletin 937: Bibliography of North American Geology, 1929–1939. By Emma Mertins Thom. Part 2: Index. Pp. 1065–1546. 2 parts, 2.50 dollars. Bulletin 940–B: Manganese Deposits of the Elkton Area, Virginia. By Philip B. King. (Strategic Minerals Investigations, 1943.) Pp. iv + 15–56 + plates 4–9. 75 cents. (Washington, D.C.: Government Printing Office, 1942–1944.) [151

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THE UNIVERSITIES AND ADULT EDUCATION

WHILE the report of the Committee on Scientific Man-Power (see *Nature*, June 15, p. 794) was not concerned with the provision of teachers generally, it has recognized in its assessment of priorities the importance of adequate provision of teachers of science, and that some universities are experiencing an acute shortage of suitable men. The Committee is not satisfied that an adequate supply of science teachers of sufficient calibre would not be forthcoming if appropriate recruiting methods were adopted, although little consideration is given to economic aspects of the situation. Other passages in the report, however, are concerned with the quality of science teaching and with the increased demand for teachers with scientific qualifications which is likely to result from the raising of the school-leaving age, the establishment of county colleges and the implementation of the proposals of the Percy Committee on Higher Technological Education. The Barlow Committee estimates that between 1950 and 1955 an additional 5,000 teachers will be required, and the report leaves a clear impression that the supply of teachers of the requisite calibre is at present one of the major bottle-necks in the expansion of the scientific man-power of Great Britain.

The McNair Committee, reporting two years ago, came to a similar conclusion. Yet the impetus to the closer planning of university development which the Barlow Report has now given has apparently made some of the universities less disposed to accept responsibility for the general supervision of the training of teachers as recommended in one section of the McNair Committee; though it is to be hoped that the plans for university development will include adequate provision for the establishment of schools of education and for educational research. There would seem to be real danger that nothing effective will be done and a great opportunity be missed. First things must come first, and in his fine chapter on "The University and its Region" in "Redbrick and These Vital Days", Bruce Truscot gives clear warning of the danger attending the failure to maintain standards, just as he indicates the great possibilities in the development of the regional work of the universities.

How important are those extra-mural activities of the universities is well brought out in a memorandum from Nuffield College entitled "The Further Education of Men and Women: a Task of the 1944 Education Act"*. Here again it is noted that the bottle-neck is in the supply of teachers. The memorandum excludes from its purview in general those grant-earning activities of the extra-mural delegacies of universities and of the Workers' Educational Association which have been proceeding on well-defined lines for more than forty years, and to the further expansion or development of which it may well be expected the

* Nuffield College. The Further Education of Men and Women: a Task of the 1944 Education Act. Pp. 72. (London: Oxford University Press, 1946.) 1s. net.

universities will give their first attention, whether or not they may otherwise explore the proposals for regional development outlined by Prof. B. Dobrée or Bruce Truscot. No clear distinction can, however, be drawn between the students covered by adult education in this narrower sense and that much wider field of adult education in general with which this memorandum is primarily concerned. In mental quality and interests, both classes have a great deal in common and, however much may be done to remove financial difficulties, which have been the main obstacle in the past to adult education in the narrow sense, until we achieve the long-term programme of university expansion and its results have accrued through a generation, adult education in the widest sense will remain a problem fraught with the greatest importance not merely to industrial efficiency but also to social welfare generally. As the memorandum points out, the purpose of education for adults is to enable men and women to live full and interesting lives : it must therefore be as wide as human interests, and not subsidiary to an ulterior purpose, whether citizenship or industry or anything else.

On that ground alone, the universities' tradition of service to adult education in its limited sense makes it impossible for them to disregard the wider field with which the Nuffield College memorandum is concerned, although the responsibility for the provision of further education has been placed by the Education Act upon the local education authorities. All that such authorities are at present bound to do, however, is to prepare and submit schemes of further education for their area, having regard to any facilities for further education provided in their area by universities, educational associations and other bodies, and consulting any such bodies and the local education authorities for adjacent areas. The extent of such schemes has not been defined, and there is danger that, unless the Minister's direction is early and specific, the local education authorities may confine their attention to the provision of county colleges simply because of their precise obligation. Moreover, as the Nuffield College memorandum recognizes, the chief difficulty with education for adults lies in the fact that to be vital it must remain voluntary, and that to meet the needs of a great variety of adults a great variety of service is essential. The memorandum leans to the view that the period between the ages of eighteen and twenty-five is the one most neglected by those concerned with adult education ; it is found easier to provide for the settled worker than for those on the threshold of working life. This transition period, however, is of the greatest importance, and often sets the tone for the whole of life.

The memorandum gives a concise and admirable summary of the work of those agencies which are at present attempting to provide education for adults, including that of the Arts Council of Great Britain, the Carnegie United Kingdom Trust, the Women's Institutes, some of which have themselves stimulated the demand for further provision. It should be noted that in the debate on the Army Estimates on June 27, the Secretary of State for War dealt at some length with his plans for education, and indicated his intention to identify army education as closely as possible with civil education. Again, the new provision for the education of children will fail of much of its effect if the parents are uneducated and take no interest in their children's education, particularly in the education of those who have begun to work and are attending county colleges. The increase of leisure is a further reason making the problem more urgent. All who are to take part in tackling the problems of reconstruction, both national and international, should be competent in mind and spirit to help in their solution.

The recommendations to which the Nuffield College memorandum leads fall under four main heads: accommodation, organisation, services at present provided by private enterprise, and teachers. The report is on firm ground in urging the need for more residential colleges, and for giving every encouragement to the movement for residential educational facilities which we have witnessed in the war years. Its proposals in this field contemplate that colleges serving a limited area will provide short courses of varying kinds, while those with a regional or national basis should provide longer courses. The wardens should be hosts and sometimes directors of studies rather than purely administrative officials. Investigation of the possibility of obtaining and adapting large houses and munition hostels which may come on to the market before it is possible to erect buildings specially planned for, or suited to, adult education is also recommended ; as well as a careful study of the comparative costs of erecting, equipping and maintaining new colleges for adult education in Great Britain and in Scandinavian countries. It is suggested that colleges should be situated in different types of area, usually in the country, but there should be some in or near towns which offer educational facilities and activities generally out of the reach of those who live in the country. For non-residential adult education widespread provision is recommended of rooms set aside for educational purposes, including discussion groups, provided with study facilities, and close to community centres and village halls. Centres for adult education serving a considerable area are also suggested ; they should have specialist equipment which cannot be provided in a small room, and also lecture rooms, theatres, etc.

Organisation constitutes a further need. Here the place of the university appears to lie primarily at the centres of the higher levels of adult study, such as tutorial class work, the further development of university extension courses and the arrangement of vacation courses and refresher courses for tutors. The signatories of the memorandum do not believe that the university is the appropriate body to undertake the organisation of pioneering educational work directed to repairing the failures of the national system of elementary education ; but they hope that the personnel of the universities, which often includes those with a special gift for popularizing their subject, should be as ready as in the past to assist local

education authorities and the various voluntary agencies. The memorandum looks to the joint regional authorities to survey the needs of their areas, while the local education authorities should utilize in the management of the proposed halls and rooms the most educationally alive body or bodies in the district; and they should see that the local committee of management, on which the local education authority should be strongly represented, itself represents many different types of interest.

In regard to services affecting education for adults at present provided by private enterprise, the memorandum includes the proposal that careful investigation should be made of the difficulties confronting those who wish to buy books, and that steps should be taken to secure a good book-selling service throughout the country. It is suggested that it would be of an enormous advantage if the public libraries had a first-class national system of issuing both standard annotated book lists in the main subjects, and occasional guides to matters of current public interest. In issuing the American *Quarterly Book List*, sponsored by the Library of Congress, the United States Government last year set an admirable example of what is possible in this field. As regards libraries, the memorandum generally welcomes the proposals of the Library Association for expansion and development of existing library services. It considers that there are enough agencies in existence to do what is required, given adequate financial backing. Similarly, the Arts Council or some like body should be made responsible for the provision of good repertory theatres and opera houses as well as concerts, in all large centres of population; and cinemas on repertory lines should be established, if not by private enterprise then by Government action.

It is in regard to the provision of teachers that the universities can make their most important contribution to adult education, although the difficulty of supply of teachers is less acute than in other fields. The need for teachers is, however, a primary need, and if teachers of the right quality can be obtained, they will be capable of dealing with the varied samples of the community whom they will find in their classes. The War has probably helped the supply, because in the Services so many men and women have been engaged in adult education work of one type or another. Efforts should be made to discover such men and women who have done good work in education in the Forces and induce them to continued similar work in civil life. A general attempt should also be made to attract to this work senior members of the universities and professional men and women all over the country who have some free time to devote to teaching. Both full- and part-time teachers are required, and the universities could also provide many more courses than at present exist for training teachers for such work, not only for the recognized adult education tutor, but also for the amateur.

It is in stressing the qualifications of teachers in adult education that the Nuffield College memorandum comes closest to the ideals outlined by Truscot and Dobrée, and indicates the strongest claims of such further education on the interest and support of the universities. Teaching in adult classes should not, in the view of its signatories, be restricted to those who make it their profession. The qualifications they have in mind are rather the scholar's approach to his subject, and the scholar's conscientiousness in presenting it to students. Enthusiasm is an invaluable quality, but it is not a substitute for accurate knowledge. Of such standards of quality, the universities are the chief custodians, and it is this that gives them their special relation to a system of education for adults. While they can themselves provide facilities for only a small minority of students or even of teachers, they can influence the education of all by extending the service they perform in the education and training of students, by instilling the principles of thoroughness in study and integrity in presentation and by extending the provision they make *intra muros* for research and teaching in the subjects of most importance for adult studies outside. It may well be hoped that the other calls upon the universities in their plans for re-organisation and expansion will not prevent them making this contribution to the whole quality of national life. It is, as Dobrée suggests, part of the obligation of universities to their region to fit their students to help shape the tremendous impulses of life, which, uncoordinated, reduce society to chaos. They must undertake the education of their students in values, and seek to produce men and women eager to develop the culture relevant to our emerging society.

That is true for their part in adult education no less than in their intra-mural teaching, and unless the universities are prepared to help in this way and on a much larger scale than in the past, there is little prospect of achieving that social integration and that understanding of values upon which the continuance of democracy depends. This is one overwhelming reason for the establishment of university schools of education, and for the universities accepting responsibility for the general supervision of the training of teachers and bringing training colleges into some closer relation with themselves. Some universities may well be reluctant to accept even indirect responsibility in this way for the training of some twelve thousand new teachers, and it seems likely at present that university schools of education and joint regional boards on which both the universities and training colleges are represented may develop side by side. This diversity may be no bad thing in itself, and experience should show which method is more satisfactory. But for efficient regional organisation, a spirit of drive and energy must emanate from the Ministry of Education itself, and there must be the vision displayed so conspicuously in the Nuffield College memorandum and by Prof. Dobrée. It is for such vision that the country has a right to look to the universities, and no excellencies in other directions will compensate for its absence in whatever plans for development the universities of Great Britain may in due course lay before the Lord President of the Council, the University Grants Committee or the Ministry of Education.

CULTURING ALGÆ AND FLAGELLATES

Pure Cultures of Algæ

Their Preparation and Maintenance. By E. G. Pringsheim. Pp. xii + 119. (Cambridge: At the University Press, 1946.) 7s. 6d. net.

THIS little volume comprises a letterpress of only a hundred pages, yet brings together results of more than thirty years of experience of cultural work of freshwater Algæ and Flagellata, much of which was carried out in Germany and is made for the first time easily accessible to the English reader. The portrait of Beijerinck as frontispiece reminds us of the work of one whose name is not always associated in Britain with algology. Eight other illustrations in the text illustrate effectively simple practical devices found to be useful in preparing, handling or maintaining cultures.

Most of the book is concerned with the principles underlying the methods most likely to be successful in culturing Algæ and flagellate unicellular organisms. These differ in several respects from those already well known for Fungi and Bacteria. In the majority of algal cultures, for example, the medium must be near neutrality, mineral salts must be given in considerable dilution and organic nutrients avoided owing to the danger of undue development of bacteria or other unwanted organisms. Wittepeptone, so often used for Fungi, seems to be contra-indicated for almost all Algæ. The important distinction is made between uni-algal (not necessarily bacteria-free) and 'pure' cultures, which contain only the one organism selected. The former are sufficient for many purposes and are much more easily obtained in most cases.

More specific directions with regard to culturing on agar and sub-culturing in soil-water liquid media are given for certain groups in Chapter 8, but even here the information is rather generalized in character.

Dr. Pringsheim has himself made a great advance in establishing pure cultures of many green Algæ, thus making possible a much more systematic study of the living forms. These cultures are available to anyone at moderate price, and will doubtless be in demand as they become more known. The reviewer had occasion to send for some of them. They grew well for a time, but no indication was given as to the nutrients used in the agar slopes, as is usual (and helpful) in standard fungal cultures. Indeed, in view of the frequent reference in the text to the variety of media available and the scattered nature of the literature in which these are recorded, it would seem worth while to have included for easy reference an appendix with a few specific formulæ of proved merit, giving the particular organisms with which they were successfully used. It is true that we are warned (p. 32) that "the precision advocated in many recipes is apt to be misleading" and that changes brought about in the medium by the organisms themselves may be of the first importance, but a formula gives at least a definite starting point, and it is only by a comparison of definite records of the formulæ, the manner of their utilization and the results obtained that the essentials may be discerned.

The author hopes to establish "a small research station" devoted to the study of Algæ. Perhaps, for a time, something of the kind might be attached to some existing or future botanical institute, but there is certainly a wide field for investigation.

The foreword by Prof. Fritsch is a most appropriate introduction to this pioneer work. Author and publisher are to be congratulated on the format and typography, which combine to make this a very pleasant little book of reference. E. M. DELF

ELECTRIC DISCHARGE LAMPS

Electric Discharge Lamps

By Prof. H. Cotton. (Monographs on Electrical Engineering, Vol. 12.) Pp. xvi + 435. (London: Chapman and Hall, Ltd., 1946.) 36s. net.

DURING the last fifteen years electric discharge lamps have been developed to an extent which makes them now a commercial product of the first importance. Uyterhoeven published an excellent survey of the subject (Julius Springer, Berlin, 1938), but there is no English translation and his book is already partly out of date. Prof. Cotton's book, the first in the English language, is therefore to be welcomed. It has been written mainly with the requirements of the electrical and the illuminating engineer in mind.

About two thirds of the volume are taken up with fundamentals necessary to an understanding of discharge lamps. Thus radiation and thermionic emission receive brief treatments; the structure of the atom and atomic spectra occupy some ninety pages; discharge phenomena and the motion of particles in the discharge are dealt with in two chapters totalling some sixty pages. There are also chapters on fluorescence and on colour and its assessment. The discussion of discharge lamps themselves and the problems involved in their operation occupy two chapters totalling 175 pages, or considerably less than half the total book.

That so much space is concerned with material preparatory to dealing with the lamps themselves raises an interesting question. In many books, a large part of the space is occupied with elementary discussions of fundamentals easily to be found in other places. This is not necessarily a fault, for it is useful to have the subject more or less complete between one pair of covers. Proper balance should, however, be maintained, and there would seem to be two criteria as to whether the practice is justifiable: the material should be restricted to that which clearly relates to the main subject, and its treatment should be concise and should bring out strongly the principles which are actually required. Prof. Cotton could have been more successful in this respect than he has been: more could be said in less space if the important aspects of the fundamental treatment were stressed and unnecessarily lengthy discussion curtailed. As an example: an elementary understanding of spectra in electric discharges does not need the long discussion in Chapter 8 on elliptic orbits; and after this long discussion, the reader will still probably be puzzled to know how the separation of the s, p and d levels is to be accounted for. There is moreover, throughout the book, a fair number of mistakes and some confusion, although fortunately not of the kind which will seriously worry or mislead the type of reader for whom the book is intended.

However, after these criticisms, there is still much to be praised. Prof. Cotton has conscientiously collected and presented most of the available informa-

tion relating to the important types of commercial discharge lamps, and a pleasing feature of the presentation is the large number of photographs and figures (216 in all) with which the book is provided. The engineer interested in discharge lamps will find the reading both interesting and informative. If he wishes to go more deeply into the subject, sufficient references are given to allow him to extend his reading without difficulty. V. J. FRANCIS

EPIDEMIOLOGY FOR PLANT PATHOLOGISTS

Pflanzliche Infektionslehre

Lehrbuch der allgemeinen Pflanzenpathologie für Biologen, Landwirte, Förster und Pflanzenzüchter. Von Prof. Ernst Gäumann. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 3.) Pp. 611. (Basel: Verlag Birkhäuser, 1946.) 48.50 Schw. francs.

BEFORE welcoming Prof. Ernst Gäumann's comprehensive "Pflanzliche Infektionslehre", a brief obituary notice of the passing of the older type of plant pathology text-book would be a graceful acknowledgment of its period of usefulness, now drawing to a close. The days of the encyclopædia of individual plant diseases are numbered, even for the undergraduate student of plant pathology. Such an encyclopædia is now of little use to the professional plant pathologist, who has at his disposal a rapidly increasing number of monographs about special groups of plant diseases, and even about single individual diseases, written with an authority that no compiler of an encyclopædia can possibly command.

"Pflanzliche Infektionslehre" is essentially a book written by a plant pathologist for plant pathologists. In his preface, Prof. Gäumann tells us that his book is the outcome of twenty years of lecturing to students at the Eidgenössischen Technischen Hochschule in Zurich; he might have added that it is also the result of a wide research experience in plant pathology. The book is divided into six chapters, which deal in turn with infection, epidemiology, parasitic specialization of pathogen, susceptibility of host, ontogenetic development of disease and control methods. Chapter 1 (100 pp.) is concerned with the mechanism of plant infection by fungi, bacteria, viruses and phanerogamic parasites, and with the effect upon it of environmental conditions and concentration of the parasite. A consideration of the various types of infection court follows, and the remainder of the chapter is devoted to the further invasion and spread of the parasite within the host (for example, localized and systemic infection, etc.). This chapter constitutes perhaps the best, and certainly the fullest, account of the physiology of parasitism to be found anywhere. Chapter 2 (110 pp.) follows logically with an account of epidemiology, dealing in turn with sources of infection (infected host plants, saprophytic phases and dormant survival organs of the parasite), and with transmission of inoculum by seed or vegetative propagation of the host, by mycelial growth through the soil, and by wind, water, animals and human agency. After a disquisition on annual and secular periodicity of epidemics, nine conditions for development of an epidemic, and three for its subsequent decline, are discussed. Chapter 3 (80 pp.) deals with parasitic specialization of the pathogen, and with its alteration through the various mechanisms of nuclear segregation, heterokaryosis, cross-breeding, mutation, etc. The chapter concludes with a discussion of the various hypotheses put forward to account for development of parasitic specialization.

Chapter 4 (222 pp.) is the longest in the book, and the slight trepidation with which the reader may embark upon it is not diminished by the formidable array of main headings (five), section headings (seventeen) and sub-section headings (thirty-four). The chapter is divided into two main parts, the first dealing with inherent susceptibility, and the second with the influence of the environment upon susceptibility. In the first part, passive defence mechanisms are discussed under the headings of disease escape, resistance to penetration, and resistance to spread within the invaded host. Active defence mechanisms are next considered under the headings of plasmatic reaction (controlling infection by nodule bacteria of legumes and by mycorrhizal fungi), necrogenous or hypersensitive reaction (for example, varieties of wheat immune to rust), and quasi-immunity reactions induced by previous inoculation (for example, for certain plant viruses). A further distinction is drawn between active defence reactions to the parasite, and those to its toxic growth products; under the second category are discussed histogenous demarcation of infected tissue (for example, abscission in shot-hole disease of peach and demarcation by cork layer in black root rot of tobacco), and gummosis demarcation (for example, silver leaf disease of plum). In the second part of Chapter 4, predisposition of the host plant to disease is discussed under the headings of ontogenetic drift in susceptibility, and the influence of nutritional and other environmental factors, including injuries and pre-existing infections, upon susceptibility.

Chapter 5 (48 pp.) treats of the ontogeny of the individual plant disease, which is discussed under the headings of teratology, pathological anatomy and histology, and pathological physiology. Chapter 6 (5 pp.) on control measures is so brief as to come as a slightly comical anticlimax to the rest of the book; its arrangement seems perfunctory by contrast with the logical development of the five preceding chapters, to the completeness of which it adds little or nothing.

Plant pathologists will find much to argue about, as well as to admire, in "Pflanzliche Infektionslehre"; but this is inevitable, and indeed highly desirable, in a work of this kind. The interpretation of host resistance phenomena, in particular, is highly controversial, and barriers of cork and gum may not be always what they seem. Again, some plant virus workers will dislike Prof. Gäumann's analogy between the barberry as alternate host for wheat stem rust, and aphis vectors as alternate hosts for certain plant-infecting viruses; multiplication of the virus in the insect vector has been freely implied, but not yet proved. Disagreements of this kind, however, can in no way detract from Prof. Gäumann's great achievement in producing a timely and extremely stimulating book. The clear and orderly arrangement of the text will facilitate use of the book for reference, and its value is much enhanced by the inclusion of 90 tables, and 311 graphs, line drawings and half-tone illustrations (some of which have suffered in reproduction). There is a good bibliography and a general index. By omitting to provide an author index, Prof. Gäumann has disdained the customary sop to the vanity of contemporary research workers, but this may assist them to a more deliberate judgment of his book. S. D. GARRETT

CIVILIZATION AND THE PURSUIT OF KNOWLEDGE*

By Sir RICHARD GREGORY, Bt., F.R.S.

Science and Invention

SCIENCE as the spirit of questioning is neither moral nor immoral; and its justification is in the accumulation and co-ordination of knowledge. A scientific discovery is an addition to knowledge; and an invention is an additional use of knowledge. On the principle that "Necessity is the mother of invention", the atom bomb was manufactured as a devastating weapon of war; but it should not be assumed that scientists, any more than other groups of people, desire to be associated with the prostitution of knowledge in any form.

When man began to accumulate experience of the properties of natural things and to apply it for his own purposes he rose above all other living creatures and began to weave the fabric of civilization. By his discoveries, he became possessed of knowledge which he is as free to use now as he always has been to distinguish between what is good for his existence and what are poisonous products of the world around him. From birth to death he has to defend himself against the many natural enemies which surround him wherever he is, or submit to be destroyed by them. He entered the world as a child beset with dangers, and under primitive conditions of life is still a victim of their aggressions.

Civilized man has, however, become a giant in his powers of meeting these attacks of natural things and forces, and has learnt how to subdue and overcome some of them, though they still demand the sacrifice of millions of human lives annually. With this knowledge has come the creation of artificial devices of destruction as antagonistic to the development of the human race as the natural processes over which a certain measure of control has been acquired. While man has been learning how to control Nature, he is still in the position of a child in his attitude and outlook towards the dangers which now encompass him, and has not realized that his duty is to overcome them, as he has always had to do to survive the perils of the natural world in which he is placed.

This world has agents of destruction far more ingenious and effective than any contrivances devised by human inventors. Man has, however, not been content to submit to suffer disease and death from these natural enemies but has battled with them, and scientific knowledge has given him the power of conquest over many of them. The same spirit is required to meet and avert the dangers to civilization created artificially, instead of pleading pathetically that they ought not to be put within his reach because he is still a child in wisdom.

At every stage of civilization there have been conflicts between communities for one reason or another, and all available resources of men and material have been used by the adversaries for their armed forces. This is as true of the weapons and machines used in warfare by primitive peoples as it is of those which have been placed at the disposal of the modern world by applications of scientific knowledge to invention.

War has always been an incentive to the use of devices to subjugate opposed armed forces; and the weapons employed have reflected the position of the industrial arts. These have advanced with knowledge of the natural properties of things, from the time when prehistoric man found that he could make cutting and piercing implements from flints, and thus started a new industry, through the bow and arrow period to gunpowder and modern high explosives to the atom bomb. It is for leaders of nations to determine among themselves whether their hearts are strong enough to make the splitting of the hearts of atoms a means of improving conditions of life on the earth and the beginning of a new era, or utterly to destroy what faiths and works have achieved in the history of civilization.

Though the machine age is regarded as having begun in the eighteenth century, the foundations of it were laid ten centuries earlier through the general use of the Latin language and the institution of monasteries in which labour was combined with devotion to high ideals in the shaping of what has become modern European or Western civilization. The distinctive feature of the present epoch is the harnessing of natural sources of energy to do work instead of using the physical powers of human beings and domestic animals to accomplish it. The inventions of the eighteenth and early nineteenth centuries came from the workshop rather than from the scientific laboratory, though revolutionary social and economic developments were brought about by them. Discoveries of science were used in those prosperous times with as much indifference to science as to humanity. There was then no moral indignation, such as is now often expressed, against mechanisms as degrading elements in civilization and destructive of spiritual goodness.

It is natural to long for a more peaceful and less-exacting condition of life than that which prevails in most modern cities and towns in this age of speed, hustle and noise; but there is no historical evidence to prove that before the machine age labouring people in large communities were any happier than they are to-day. The primary needs of human life are food, clothing and shelter, and in the search of them man follows instinctively his animal instincts. He may be contented when these wants are supplied from natural or national resources without undue effort, but his condition is that of the beast in the field or a cave-dweller of prehistoric times. Civilization begins when intelligence is used to increase these resources and to construct a cultural pattern, however primitive this may be.

Whenever natural sources of energy are made available for mechanical work by the use of wind or water power, or combustion of coal or oil, slave labourers of giant strength and untiring capacity enter the service of man and enable higher standards of living to be attained. It is not suggested for a moment that developments of this kind necessarily increase happiness or represent more than a single factor capable of contributing to progressive human welfare. As, however, man has a mind and the unique power of making useful or decorative things from the materials and forces in the world on which he is placed, it must be his duty to bring these gifts and talents into operation.

Languages of Expression

When humanity emerged from its sub-human ancestry, its inherited instincts began to have their impulses determined by a reasoning faculty and it became possible to acquire and accumulate knowledge to be handed down from one generation to another.

* Continued from page 118.

In this respect, therefore, the human race can be said to mark a distinct stage in the evolution of life, and its advances in any direction to represent progress.

All such advances originate in new concepts or ideas which may or may not take material shape. Every new idea is, however, a stimulus to further intellectual expansion or practical endeavour, and civilization is the record of their development. Measured by the means of increasing the material welfare of mankind, science and invention may claim always to have led the way. The laws and principles they discover and apply are additions to knowledge by which conditions of life can be improved in this world during the short period of occupation by the human race. What is our destiny here we do not know, but while we are alive it is our obvious duty to do everything in our power to raise standards of living and find out at the same time the relation of our small planet to the many millions of other bodies in the universe.

The moral law is apprehended by a different set of experiences from that of natural science. Recognition of its influence as well as of the utility of knowledge determine together the progress of civilization. In each case the aim must be the attainment of the highest good on this earth whatever the ultimate destiny of the human race may be. Goodness, truth and beauty are abstract ideas appealing in diverse ways and tones according to attitudes of mind, but appreciation of their qualities is not excluded from the field of natural science any more than it is from other factors which constitute human progress.

Intellectual expansion and the forms in which it is expressed are distinctive attributes of human nature and elements of progressive development. When the Sumerians became urbanized nearly five thousand years ago, they found it necessary to introduce seals and clay sealings as guarantees of authenticity of commercial contracts and legal obligations. With these seals they developed a system of pictographic writing on clay tablets, which evolved into the cuneiform script. As the temple was the centre of the Sumerian civic organisation it was also, through the development of writing, the cultural centre where knowledge was accumulated and used. The inscribed seal had a most important effect on the development of art, while the necessity for a dignified and fitting home for the god led to advance in style in building worthy of the name of architecture, to which the use of mud-brick could have contributed in no other way.

Drawings provide a universal means of representing objects, and their characters also convey individual or composite emotions and meanings. Many early forms of writing are conventional characters developed from pictographs of this kind; and out of these conventionalized marks alphabets were constructed or characters were combined to represent syllables. All human beings express certain emotions, such as anger and fear, by much the same sounds, signs and gestures, and all can interpret simple picture writing, as all can understand the meanings of actions reproduced in modern moving pictures, silent or sound. There are, however, many conventionalized forms of characters to represent these sounds and thoughts by written or printed words, and these combinations make up the many languages of the world.

Pictographs or ideographs thus evolve into symbols representing gestures and sounds and then to alphabets, the letters of which are combined in words to convey ideas from one place or time on the earth to another, however far or long they may be separated. Sounds were combined to express emotional feelings in the earliest civilized times; but the history of the art of music cannot be traced like that of literature because no musical compositions from those times have had their forms or contents preserved.

While, therefore, the contribution of a people or a period to the expansion of the human mind can be found in its literary records, and comparisons made between them on a scale of refinement, there is no clear relationship between early and modern practices of the musical art. The melodies of primitive peoples to-day do, however, afford an indication of rudimentary combinations of sounds; and this folk-music has its own standards of excellence. Progress in music as an art, like that of literature, is in the exalted combination of the notes of a chromatic scale into a composition which arouses in its readers or listeners the emotional feelings which their writer wishes to convey. Fertility of creative ideas and the forms to which these give shape are the measures by which progress in all these arts of expression may be judged.

Increase of opportunities to read and hear what is thought or said in words or music is of even greater importance in the history of civilization than the works themselves. This began with the production of books in which raised letters or other characters were impressed upon the pages with ink or other pigment. Much of the early printing was done with page-blocks of this kind; and the same plan is adopted in printing from stereotyped plates of pages to-day. The use of movable type was first introduced by a Chinese alchemist and inventor, Pi Shêng, in the eleventh century. He used type made of baked clay and experimented also with wooden type. A later improvement made in China was to use tin for the movable type. Early in the fourteenth century movable types were made in Europe of wood, tin and lead, but the modern art of typography may be said to have begun when in 1454 Johann Gutenberg issued from his printing press at Mainz, books printed from types cast in a mould.

From a cultural point of view the value of the invention was in the extension of opportunities of acquiring knowledge through book-learning. There were literary works and libraries in Assyria, Babylonia, Egypt and China in very early times, but each had to be separately written by hand. A book is a collection of scripts joined together to form an organic whole so as to be portable. The first books may thus be said to be those written on papyrus in ancient Egypt. Several rolls of this kind, with columns of hieratic writing done about 2500 B.C., have been found in tombs and are preserved in national museums. They are samples of many early Egyptian writings of a didactic and moral character, apart from religious spells and praises of the divine. Most of this secular and sacred literature preserved on rolls of papyri were made for school use by young scholar-scribes. There were wonder-tales, romances, humorous and gruesome stories, moral admonitions, types of worldly wisdom and rules of devotional conduct towards divine influences, in the East five thousand years ago, as characteristic of human life and its spirit as is the literature of classical and modern times.

The invention of mechanical printing, and the use of paper instead of papyrus, made it possible to produce the many millions of books now in libraries and for the knowledge and wisdom of all peoples to be

distributed throughout the civilized world. It is in the extension of this intellectual influence and the continuous development of processes of reproduction that the art of printing has reached the high position as a cultural force which it occupies to-day.

In so far as art, literature and music are expressions of the human spirit as well as reactions to conditions of life, any agency which multiplies their points of contact may justly be said to aid the progress of the race by expanding the outlook. This is what was done when printing presses converted the small corps of transcribers into a great mechanized force in the front line of civilization. The advance was in apparatus for manifolding literary compositions and thus giving wider range to the light of the torch of learning.

World Services

The value of devices for reproducing words and sounds, written or spoken, lies, therefore, in the increased contacts between human minds, and the measure of truth attained in the reproduction. This has reached a high degree of perfection through the combination of mathematical theory and physical experiment; with the result that broadcasting truly brought about a condition when "Their sounds went out into all the earth, and their words unto the ends of the world". These developments began with the invention of means of producing and detecting electromagnetic waves other than those in beams of light and transmitted with the same velocity of 186,000 miles a second. What has since been achieved so impressively is due to the use of increased power to create such waves, and increased sensitiveness of instruments to detect and reproduce their qualities. This has been made possible through the increase of knowledge of the atomic structure of matter in relation to the energy of electric waves. The electrons contained in the atoms of all forms of matter were found to be identically the same, and when these are torn off by thermal or electrical influence they constitute a stream of invisible particles which travel with the speed of about one tenth of the velocity of light.

The basis of all systems of radio transmission of sounds or scenes is the production of electrons and the detection of their effects. In a radiolocation equipment, the particles create pulses of waves which are reflected by objects in their path, as sound-waves are reflected in echoes. Though the interval of time between the dispatch of the waves and their reception is extremely short, it is clearly shown on the time-scale of the apparatus used and becomes a scale of distance. As radio-waves are reflected by obstacles of any kind, they can be used in darkness as well as daylight, in thick fog or other obscuring atmospheric conditions, as light to show whether the way is open or not. Radiolocation, or 'radar' as it is now termed, has thus given civilized peoples new powers of electric vision which are already being used to ensure safety of movement on the sea as in the air, in addition to the detection of small or distant enemy aeroplanes and submarines, for which purposes the instruments used were designed and applied with conspicuous success.

All mechanical aids of this kind, whether phonographic or photographic, are often referred to contemptuously as scientific gadgets which are, on the whole, detrimental to progressive spiritual development. It is suggested that because they are created by man's own efforts, without appeal to supernatural influences for guidance or reference to religious faith, pride in them is to be deplored rather than encouraged. By the same token, the natural machine power of modern times is regarded as a failure, and a return to supernaturalism is urged as the only means of shaping a new and better world.

To assume such an attitude towards civilization is irrational and puts two different standards of value in conflict instead of regarding them as complementary to one another. It surely must be the duty of man to learn as much as he can of the material universe, and of the earth upon which he has to live: and it cannot be wrong for him to discover and apply knowledge of natural properties and forces, whether these are understood as having been created for his service or not. To condemn such knowledge as having a numbing effect upon aspirations of the human soul, and the machine age as a degrading period in the upward growth of mankind, cannot be justified either historically or rationally. What is wanted to-day more than at any other epoch of civilization, because of the powers which have been placed at the disposal of civilized peoples, is the strengthening of the human heart everywhere to act upon the principle of brotherly kindness, contained in the maxim common to all religions and ethical systems: do not unto others what you would not they should do unto you.

Civilization and Ethics

Civilization is essentially distinguished from barbarism, and man from other living creatures, by the effects of high spiritual ideals upon human conduct. Many of these ideals are common to all peoples, and the values attached to them determine both individual and social endeavour. The standard of attainment reached by a human society towards all elements of 'goodness' is a measure of the place of the society in a civilizing process. The pursuit of natural knowledge may claim to be one of these ennobling elements, as it leads not only to means of improving conditions of life but also to a broadening of man's intellectual and social horizons. Devotion to these objects, courage of enterprise, faithfulness to truth and humility of understanding represent the spirit of science as truly as they are combined in other fields of thought and action. The relation to moral goodness of the results achieved depends mainly upon the attitude taken towards natural knowledge and supernatural revelation.

As ethics is the science of morals in their widest sense, it is concerned with the influence of each of these attributes upon the character of the individual and the structure of society. What man is in himself, and what are standards of moral righteousness, have varied greatly with cultural conditions in the history of civilization. A system of ethics, or rules of conduct, by observance of which conduct in life is brought into harmony with cosmic principles, is a part of all religions and is associated with many conceptions of deities and conventional forms of worship. In all ethical systems, as in all high religions, certain elements of human goodness or virtue are esteemed, and attachment to them is a measure of righteousness of life.

Socrates taught that in itself right "knowledge is virtue"; but it was Aristotle, the greatest of the Greek naturalists, who held that happiness or goodness, which in the individual means 'well-being' and to the community 'well-doing', should be the aim of an ethical system. His knowledge of natural history was copious and comprehensive, and he used it to

co-ordinate what was thought or known about living things into a science, while at the same time he showed that appreciation of truth and beauty in Nature does not impair promotion of the quality of goodness of a way of life. The ethics of human conduct taught by Confucius two centuries earlier constituted a similar code of practical morality in a civilization which takes a high place in the history of man and his works.

The highest type of social organisation is that in which both material good and ethical goodness are rightly balanced. As material progress must in its nature be more striking, more patent to observation, than progress in man's ethical and social development, there must always be a lag in time between the operations of the two forces. The idea that the scientific and inventive mind is necessarily antagonistic to the merciful heart is as degrading to knowledge as it is untrue of the virtue of goodness. The gap between application of the two qualities is due to the selfish sides of human nature, and not to the increased power and supplies which knowledge provides for the primary needs of life.

It is permissible to indicate how this knowledge could be used in the construction of a new world, whether for better or worse, but no one believes that improvements of material conditions can be made a measure of ethical goodness. This, however, is what is asserted to be the position occupied by science in visions of the development of the human race in the past, present or future. It is the basis of a charge that advances in natural knowledge are inimical to the growth of the noblest attributes of the spirit of man. We have had, therefore, literary pictures of machinery being developed to such a dangerous stage that it had to be abolished, and on the biological side to conceptions of a world of planned types of inhabitants, each, like social communities of insects, with intellectually deadening functions to perform.

Literary works of this kind are parodies or satires of potentialities of applications of knowledge, and in no way represent a scientific view of the factors which have enabled man to survive and reach his present position. It is true that, by the release of atomic energy, modern civilization has been provided with the means of destroying itself, but the same power is available for making the earth a celestial dwelling place, just according to the service to which it is put. There is now, as always, freedom of choice between good and evil fruits of knowledge; and the ways in which these are cultivated or controlled will be the reply to the menace now facing civilized peoples. All who have goodness in their hearts and goodwill towards their fellows should unite in meeting this challenge to movement onward and upward.

Progressive Humanism

Faith in this spirit, in whatever way it is promoted or manifested in the works of man, is often regarded as presumptuous pride in his creative and constructive capacities and therefore irreligious in the sacred meaning of the word. The spirit is, however, associated with all aspects of intellectual and material progress which have influenced the course of civilization. Devotion to it is the religion of secular or scientific humanism, because its principles do not include knowledge of the supernatural and relate only to the practical application to life of the favourite Christian maxim of the British monk, Pelagius, "If I ought, I can".

Humanism in this sense is the integration of all influences which promote the development of the human race, whether associated with the teaching of a particular religion or not. Principles or practices which raise man out of his animal ancestry and add to his status among living creatures can rightly be termed humanistic. Their spirit is displayed in works of science as well as in art and literature; and the measure of their value is that of the opportunities these afford for improving human welfare on the highest standards that the mind can conceive and the heart will sanction.

Whatever convictions are held about the meaning and purpose of man's existence, he finds himself on a globe from which he has to obtain the needs of life, and also with a mind which can appreciate such abstract qualities as beauty and love, goodness, justice and mercy, whether seen on the earth or projected on the heavens. Modern humanism takes account of all these factors of cultural development, secular or sacred. It understands very clearly that the earth is but a temporary home, not only for the short span of individual life, but also for the whole human race. As tenants or trustees our duty is to make the best use of the resources of our heritage by the exercise of all our talents, and with the belief and hope that by so doing we are contributing to make men god-like if not godly in the sense of religious faith. So may the earth be made a part of the heavens of the universe in spirit, as it is in truth.

DEFENCE AGAINST THE ATOMIC BOMB

THE news of any further increases in the effectiveness of the atomic bomb would at the present time be received with universal disgust or indifference. The discovery of a successful defence against it would occasion equally universal satisfaction and relief. It may be doubted whether the distribution of the world's expenditure on research between the two aspects of the subject—offensive and defensive—takes account of this world-wide prejudice in favour of survival. The publication of the recent report of the British Mission to Japan*, with its unequivocal emphasis on the defensive point of view, is therefore doubly welcome, first as indicating that the British Government does not necessarily subscribe to the view that no defence is possible, and secondly as providing a starting-point for any defensive investigation.

The plain fact, plainly stated in the report, is that an atomic bomb of power equal to those dropped in Japan, if used without warning on a large city of European construction having an average population density equal to that of London, would kill about 50,000 people, and would start fires numerous enough to be uncontrollable over an area of several square miles. The consequences of such an 'incident' can be traced in some detail, but detailed knowledge is not required to grasp the magnitude of the catastrophe.

It must apparently be assumed that a defence by counter-attack on the weapon itself—for example, by a device causing detonation before the target is

* The Effects of the Atomic Bombs at Hiroshima and Nagasaki. Report of the British Mission to Japan. (Published for the Home Office and the Air Ministry.) Pp. vi+22+24 plates. (London: H.M. Stationery Office, 1946.) 1s. net.

approached—is not feasible, and on this ground various statements have appeared that no defence is possible. No device of this kind exists for exploding ordinary bombs, but even the most convinced advocate of strategic bombing would not assert on that account that some defensive measures are not both possible and necessary.

Defence against every weapon must be based on its limitations. The extraordinary power of the atomic bomb may suggest that its potentialities are unlimited; but such is not the case. At present, its limitations appear to be three-fold: (i) it has a minimum size, and this size is, compared with other bombs, enormous; no small atomic bomb is possible; (ii) it is extremely expensive; only a nation of great industrial power can hope to produce atomic bombs in substantial numbers, even in the absence of international control of the necessary materials; (iii) if the bomb is detonated at the height required to effect maximum structural damage (as was done at Hiroshima and Nagasaki) quite elementary shelters like the 'Anderson' can be made to provide adequate protection against blast. While no direct evidence exists, it is possible that underground shelters generally would only be demolished within a comparatively limited area, even if the bomb were detonated at ground-level or below. These limitations are not removed if the bomb is made still more powerful, unless at the same time it becomes either easier to manufacture or capable of being detonated in smaller quantities.

Against some societies, then, the atomic bomb is almost useless. Consider, for example, an army, widely dispersed in trenches and dugouts, and provided with an adequate warning system. An attack by atomic bombs would, no doubt, cause some casualties by 'flashburn', although even ordinary clothing appears to offer substantial protection against it, and some would die of 'radiation sickness'. The latter, however, would not become ill for a week or so after the event, by which time the battle might be over. (This comparatively long time-lag suggests to the layman that further research may lead to a decrease in the proportion of deaths among those exposed to gamma radiation.) There would be few blast casualties if the troops were not housed in buildings liable to collapse and bury them. Possibly there might be some psychological reaction, but the experience of the last six years suggests that the survivors of a terrifying, but ineffective and short-lived, attack experience not depression but rather the reverse. The commander of an attacking force would scarcely expend his precious bombs on so unrewarding a target, and the slogan which circulated in Britain during the blitz period, "Safety first—join the Army", would, in an atomic war, become almost the literal truth. Similarly rural areas, villages, and small towns are uneconomic targets, and can be regarded as practically safe.

It is on these lines that a defensive strategy must go forward. The total 'war potential' which goes into the manufacture of an atomic bomb, conveniently measured in terms of electric power, has not been made public, but is certainly large. (The Smyth Report states that to make 1 kgm. of plutonium in one day takes a power supply of the order of one million kilowatts—half the ultimate capacity of the Grand Coulee power plant—and that a bomb requires several kilogrammes of plutonium.) An accurate estimate of the total expenditure involved, taking into account both the supply of raw material and the industrial effort in manufacture, must now be available to the authorities. They can also estimate the proportion of 'potential' bombs which never reach the target, as a result of interference, either with the processes of manufacture or during the final stage of delivery. They are thus in a position to specify the 'minimum economic target', let us say the least important town against which atomic attack is just worth while. To do so they are forced to set a value on human life in terms of the industrial effort of the enemy; but this disagreeable necessity arises often in war, and they have not a few precedents to guide them.

It is always argued, by the protagonists of any offensive weapon, that to balance the effort expended by the attacker against the damage inflicted on the defender is incorrect. There is, according to them, a large but imponderable 'morale' effect which should be taken into account. No doubt the element of surprise does give a psychological value to a new weapon the first few times it is used, but there is not the smallest evidence that any such effect persists for a longer period. The Ruhr continued to function until it was materially destroyed. The economic effects of bombing in Great Britain were no greater, indeed in many cases they were less, than would have been expected on a basis of purely material calculations.

Given a definition of the 'minimum economic target', the government of a country threatened by atomic warfare could proceed to plan accordingly. A few industries in which concentration is essential, and of importance so great that they form valuable targets in themselves, might go underground, where they would be difficult both to find and to attack. Evacuation of large cities would be carried to an extent never before considered. The city-dweller would have to be accommodated, not in the houses of the countryman, but in temporary or camp towns of the kind which sprang up with miraculous rapidity at the time when the forces for the invasion of Europe were massing in Great Britain, and which would be not simply dormitories, but centres of a still more diffuse and decentralized industry. Obviously the problems presented vary widely with the structure of the nation attacked. They are most difficult for the highly industrial and densely populated countries of Europe; but simple to the point of being non-existent for scattered rural and agricultural communities.

The aim of the defender must be to allow, or even to encourage, his enemy to expend all his efforts in accumulating an ever-increasing stock of atomic bombs, without ever offering a suitable opportunity for using one. Whether this ideal could be achieved depends on the size of the 'minimum economic target' and, writing without official information, only the wildest guesses as to this quantity can be made. To the writer it seems that a town of 20,000 inhabitants provided with small shelters of the Anderson type or better, and equipped with an adequate warning system, would be a poor target for an atomic bomb. (The rate of progress in radar suggests that a few minutes warning of the approach of even the fastest rocket projectile may not be too much to ask.) Further, the increased use in the future of the framed multi-story construction, to be advocated both on architectural grounds and for blast resistance, might do much to solve the problem of rehousing, which even in a town of population 20,000 would be very serious.

The view is often expressed that atomic war would be the end of civilization. No doubt it would be the end of the colossal sprawling cities which at present deface the horizon of the industrial nations. The inherent badness of such cities is being increasingly recognized, and their doom is sealed even if the threat of war becomes so remote as to be inconsiderable. But there is no reason to suppose that our civilization depends for its life on the existence of the big city. Room could be found for the present population of Great Britain within the present area, in towns none of which exceeded the 20,000 limit, and none of which was closer than five miles from its neighbours. Two hundred years ago there was not a town in Great Britain, with the exception of London and perhaps one or two others, large enough to be considered as an atomic bomb target. But it is at least arguable that in some respects the civilization of that period was not inferior to our own.

D. G. CHRISTOPHERSON

LIFE AND THE SECOND LAW OF THERMODYNAMICS

By DR. J. A. V. BUTLER

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WHETHER life processes obey the second law of thermodynamics or if life finds a way of evading the otherwise universal dissipation of energy has been something of a puzzle for a century. Kelvin left the matter open in his formulation of the Second Law, by expressly excluding the operations of 'animate agencies'. Since then, opinions on both sides have been expressed, although a majority would probably be found in favour of the view that any local increase of 'free' energy is compensated by a greater amount of dissipation elsewhere, or as Schrödinger has recently put it[1] in picturesque if somewhat inaccurate language, the organism feeds on 'negative entropy'. On the other hand, G. N. Lewis[2] referred to living organisms as "cheats in the game of entropy", which "alone seem able to breast the great stream of apparently irreversible processes. These processes tear down, living things build up. While the rest of the world seems to move towards a dead level of uniformity, the living organism is evolving new substances and more and more intricate forms."

The matter has been dangerously simplified by many writers by an over-emphasis of the entropy factor[3]. Clausius's statement that the entropy of the universe tends to a maximum, combined with the rather loose identification of entropy with disorder, has led to the formulation of the second law as a universal tendency towards disorder. The fact is that a decrease in disorder can be compensated by a decrease in energy, as when a liquid freezes. The most convenient formulation of such tendencies in limited systems is that the Gibbs free energy decreases in all spontaneous changes at constant temperature. This quantity is expressed by

$$F = H - TS,$$

where H is the energy or, more strictly, the heat content and S the entropy.

My attention was somewhat forcibly drawn to these matters by observing the growth of fungi such as *Penicillium notatum* in flasks. There is no question here of the absorption of energy from light as in plants. A few spores of the fungus placed in a closed vessel in the dark in a suitable nutrient medium, such as the Capek–Dox solution, containing merely sugar, nitrate, phosphate and small quantities of a few metallic salts, become in the course of a week or two a highly complex mass of living tissue. For example, Steinberg showed[4] that the dry weight of the tissue formed with *Aspergillus niger* was frequently equivalent to 52 per cent of the total amount of sugar supplied.

Apparently a considerable increase in the complexity of the contents of the flask has taken place. The question I wish to ask is whether the 'spontaneous' change which has taken place under the influence of the spores is in accordance with the Second Law or not. To put it concretely, if the flask is kept at constant temperature and nothing enters or escapes, is the free energy at the end greater or less than the free energy at the beginning? An exact answer to this question obviously involves a complete knowledge of the final contents of the flask. If a detailed analysis were available we might conceivably draw up a free-energy balance sheet. Since that is clearly impossible, we can only make simpler and incomplete tests. The essential substances which have to be elaborated in growth processes are proteins, so the most appropriate question to ask is, What is the free-energy change in the elaboration of a protein?

Soluble proteins have been isolated having a great variety of molecular weights, from 18,000 for ribonuclease to 8,000,000 in hæmocyanins. The crystallization of native proteins, their X-ray patterns, their high specificity and the ease with which they are denatured (that is, disorganised) show them to be structures with a high degree of order. The nature of this organisation is not definitely known; for example, whether the amino-acid residues are arranged in linear arrays or in flat or closed surfaces. However, the exact nature of the organisation is immaterial for the present purpose; we need only suppose that the protein molecule is a definite and unique arrangement of the constituent amino-acids.

Experimentally, the determination of the free energy of a protein would involve establishing an equilibrium between it and its constituents. No such equilibrium has ever been observed, and all the facts indicate that the concentration of protein in equilibrium with amino-acids is vanishingly small. Furthermore, although one or two cases of reversible denaturation of enzymes have been reported[5], these almost certainly involve only limited changes in the molecule and not complete disorganisation. It would appear that equilibrium in the process

$$\text{Native protein} \rightleftarrows \text{completely denatured (disorganised) protein}$$

is overwhelmingly on the side of the latter.

One important factor in the entropy of the protein molecule will be that involved in assembling the residues into one particular pattern, out of the many millions of possible arrangements. This quantity, which we may call the configurational entropy, is easily calculated. Suppose that the protein molecule contains altogether N amino-acid residues, made up of N_1 of type 1, N_2 of type 2, etc. The number of different ways in which these can be arranged in a *linear* array is

$$P = N!/N_1!N_2!, \text{ etc.}$$

which, for reasonably large values of N, can be evaluated as

$$\log P = N\log N - \Sigma N_i \log N_i.$$

This expression is for an assemblage having a co-ordination number two, but the values of P for other types of co-ordination are probably not significantly different. (For this information I am indebted to the late Dr. W. J. C. Orr.)

The configurational entropy of the protein, arising from the fact that the protein is one out of numerous possible arrangements, is $S = - R \log P$, so that we have for the configurational entropy per amino-acid residue:

$$\frac{S}{N} = - R \log_e N - R \Sigma \frac{N_i}{N} \log_e N_i.$$

In the case of pepsin, for example, N is approximately 300, so that the first term in this expression amounts to about -11 entropy units (cal./deg.) per residue. This would be the configurational entropy of a protein made up of 300 *different* residues. In pepsin the largest quantity of a single amino-acid is tyrosine, present to the extent of 10 per cent, for which the second term amounts to about 0·7 entropy units. If there were ten amino-acids each present to the extent of 10 per cent, the second term would amount to -7 entropy units, and the configurational entropy would be about -4 units per residue. The following table shows the configurational entropies calculated in this way for molecular weights between 35,000 and 3,500,000 and on the assumptions of (1) ten different amino-acids each present to 10 per cent, (2) twenty different amino-acids, 5 per cent of each in the molecule.

M	N	$-R \log_e N$	$-R\Sigma \frac{N_i}{N} \log N_i$		$-\Delta S$	
			(1)	(2)	(1)	(2)
35,000	300	11·3	6·8	5·5	4·5	5 8
350,000	3,000	16·1	11·3	10·0	4·8	6·1
3,500,000	30,000	20·5	16·1	14·5	4·3	6·0

We conclude that the configurational entropy of most proteins may be expected to be between -4 and -8 entropy units per amino-acid residue.

This, of course, is not the only factor which has to be considered in an estimate of the free energy of formation of a protein. The process of synthesizing the protein may be supposed to consist of two parts: (1) the formation of peptide bonds; (2) the ordering and aggregation of peptide chains. An estimate of the free-energy change in the formation of the peptide bond has been made by Borsook and Huffman[6]. They found that in the synthesis of *dl*-leucylglycine from *dl*-leucine and glycine there was a free energy *increase* of 7,520 cal., a fairly considerable quantity. Supposing that the denaturation of the protein is a disordering or disaggregation of the peptide chains, we may use the heat of denaturation, taken with the opposite sign, as a measure of the heat-content change in formation of the orderly structure of the protein from a disordered peptide chain. This has been measured in the cases of pepsin and methaemoglobin and amounts to $\Delta H = -300$ cal. per amino-acid residue[7]. Combining this with the configurational entropy associated with the formation of one particular arrangement of amino-acids ($T\Delta S =$ c. $-1,500$ cal.), we find the free-energy change associated with (2) to be

$$\Delta F = -300 + 1,500 = 1,200 \text{ cal. per residue.}$$

These calculations are admittedly rough and based on inadequate data; but if they are not totally incorrect they indicate that the configurational entropy is not a dominant factor in the free energy of a protein. If an organism can synthesize peptide bonds, it appears that it will have no great difficulty in putting together protein molecules of any degree of complication. The free energy must come from the metabolic processes going on in the organism. The complete oxidation of a glucose molecule to carbon dioxide and liquid water yields approximately 700,000 cal. of free energy per mol. This is of the order of magnitude sufficient for the building up into proteins of about a hundred amino-acid residues. There is thus no outstanding difficulty in accounting for the synthesis of living structures with a fairly modest expenditure of food.

[1] Schrödinger, E., "What is Life?" (Cambridge University Press, 1944).
[2] Lewis, G. N., "The Anatomy of Science" (Yale, 1926).
[3] Needham, J., "Time: the Refreshing River" (London: Allen and Unwin, 1943).
[4] *J. Agric. Research*, **59**, 731, 749 (1939); **60**, 765 (1940).
[5] Northrop, *J. Gen. Physiol.*, **16**, 323 (1932). Anson and Mirsky, *J. Gen. Physiol.*, **17**, 399 (1934).
[6] Schmidt, "Chemistry of the Amino Acids and Proteins" (1938), chap. 15, 865.
[7] Conn, Kistiakowski and Roberts, *J. Amer. Chem. Soc.*, **62**, 1895 (1940); **63**, 2081 (1941).

MANGANESE METABOLISM IN SOILS

By Dr. P. J. G. MANN and Dr. J. H. QUASTEL, F.R.S.
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THE variety of changes undergone by manganese in soils has been the subject of study by many workers, particularly by those interested in 'manganese deficiency'. This is a condition of the soil in which manganese may occur abundantly and yet is not available to the plant in the form or in the amount required for healthy growth.

Our interest in this problem was aroused in the first instance by the discovery that phosphate extracts of soils often give a colour reaction with benzidine which is identical with that obtained when this reagent is added to suspensions, or colloidal solutions, of manganese dioxide. It was thought at first that the substance in the extract reacting with benzidine might be an organic complex in which a higher oxide of manganese was incorporated; but subsequent investigations (not yet published) by H. G. Dion and P. J. G. Mann in this Unit have proved that the responsible substance in the phosphate extract reacting with benzidine is the trivalent manganic ion. Moreover, these workers have also shown that it is pyrophosphate, present as an impurity in many phosphate preparations, which is responsible for combining with and extracting trivalent manganese in a soluble form from soils.

During the last three or four years we have carried out experiments designed to throw light on the mechanism by which manganese undergoes transformation in soil.

Biological Oxidation of Divalent Manganese in Soils

When manganese sulphate is continuously perfused through neutral or slightly alkaline soils (for example, at *p*H 7·9) at 70° F. using the apparatus of Lees and Quastel (*Chem. and Ind.*, 26, 238; 1944) and daily analyses are made of the manganese present in the soil perfusate, it is found that following the relatively rapid achievement of cationic equilibrium between perfusate and soil, manganese usually disappears from the perfusate at first slowly and then at an increasingly rapid rate until almost the whole of the manganese has disappeared. The initial lag period is variable. Its duration and the velocity of the subsequent rapid rate of removal of manganese from the soil perfusate appear to depend greatly on the nature of the soil under investigation*. A typical curve is shown in Fig. 1, A.

The manganese which disappears from the soil perfusate is found in the soil itself in an oxidized form. It has been estimated manometrically by making use of the reaction

$$2MnO_2 + 2NH_2OH = Mn^{++} + N_2O + 3H_2O,$$

which we have found to apply quantitatively to manganese dioxide either alone or when added to soil at *p*H 2. Special precautions must be taken, however, in applying this reaction to soil; for example, phosphates must be added to mask the iron present, as ferric ion reacts with hydroxylamine with gas production. Details of the application of this reaction to the estimation of MnO_2 in soils will be published in due course. Trivalent manganic ion also reacts with hydroxylamine with gas production, so that the gas evolved on addition of hydroxylamine to soil (after due precautions have been taken to mask the iron) is due to the mixture of manganic ion and manganese dioxide present. The increase in gas evolution, on addition of hydroxylamine to soils, at various times after perfusion of manganese sulphate has commenced, may be taken as a measure of the amount of higher oxides of manganese present. This may be calculated for convenience, and for the time being, as 'MnO_2' according to the equation given above. A typical curve showing the rate of formation of 'MnO_2' during a perfusion of manganese sulphate is given in Fig. 1, *B*. The curve shows, as might be expected, the same characteristics as Fig. 1, *A*—a lengthy initial lag period followed by a relatively rapid rate of formation of higher oxides of manganese.

The kinetics of manganese oxidation by neutral soils are those to be expected if the oxidation of manganese in soils under the given experimental conditions is wholly or almost wholly accomplished by proliferating micro-organisms. This conclusion is supported by the fact that the velocity of formation in soil of higher oxides of manganese is optimal at a relatively low concentration of manganese sulphate in the perfusing fluid. This concentration in one series of experiments was 0·02 *M*., above which an increase in the divalent manganese concentrations in the perfusing fluid led to a rapid fall in the rate of formation of higher oxides of manganese.

Effects of Biological Poisons on Manganese Oxidation in Soils

Such diverse cell poisons as chloretone, sodium iodoacetate and sodium azide when added to a soil perfusate containing manganese sulphate bring about a marked inhibition of the rate of formation of higher oxides of manganese in soil. The inhibition with sodium azide may be more than 95 per cent. Typical results are shown in Table 1. These results lead to the conclusion that, under the given experimental conditions, the oxidation of manganese in soils which we have investigated is almost entirely accomplished by biological means.

* Mn'' in the perfusate was estimated by oxidation with periodic acid to permanganate (H. H. Willard and L. H. Greathouse, *J. Amer. Chem. Soc.*, 39, 2366; 1917).

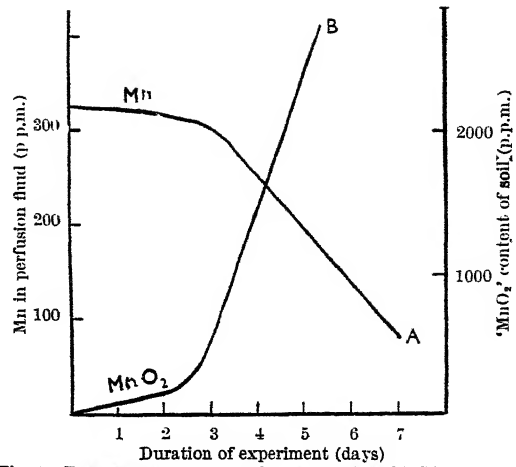

Fig. 1. EFFECTS OF PERFUSING 200 ML. 0·02 *M* $MnSO_4$ THROUGH ROTHAMSTED SOIL AT 70° F.

TABLE 1.

EFFECTS OF CELL POISONS ON OXIDATION OF MANGANESE AT 70° F. BY A ROTHAMSTED SOIL (50 GM.).

Perfusion fluid	Increase in 'MnO_2' in parts per million of soil			
200 ml. 0·02*M*. $MnSO_4$	3400	3800	3860	3520
200 ml. 0·02*M*. $MnSO_4$ + 0·001 *M* sodium azide	60			
200 ml. 0·02*M*. $MnSO_4$ + 0·001 *M* sodium iodoacetate		260		
200 ml. 0·02*M*. $MnSO_4$ + 0·4% chloretone			1030	0

Manganese Dioxide as a Biological Hydrogen Acceptor

Manganese dioxide is reduced with great ease to form divalent manganese ion by sulphydryl compounds, for example, thioglycollic acid, cysteine or by polyhydric phenols such as quinol, catechol, gallic acid, etc. The kinetics of these reductions may be followed manometrically in the Warburg apparatus by carrying out the reactions in an atmosphere of carbon dioxide. The following reactions take place

$$2\,RH + MnO_2 = 2R + MnO + H_2O;$$
$$MnO + CO_2 = MnCO_3.$$

The velocity of uptake of carbon dioxide is a measure of the rate of reduction of the MnO_2 by the reducing body *R*H.

It is easy to show that suspensions of bacteria in presence of suitable hydrogen donators and traces of such carriers as pyocyanine or methylene blue will bring about a reduction of manganese dioxide. The reactions may be allowed to take place in an atmosphere of carbon dioxide, the velocity of absorption of which is a measure of the speed of reduction of the MnO_2 by the bacteria. The following reactions occur:

$$\text{Pyocyanine} \xrightarrow[\text{(bacterial suspension)}]{\text{H. donator +}} \text{Reduced pyocyanine;}$$

$$\text{Reduced pyocyanine} + MnO_2 = \text{pyocyanine} + MnO + H_2O\,;$$

$$MnO + CO_2 = MnCO_3.$$

Some typical results, using washed suspensions of freshly grown 'propionic acid' bacteria (Strain 4759 of the National Collection of Type Cultures), are shown in Table 2.

TABLE 2.

REDUCTION OF MnO_2 (0·2 ml. *M*/10 SUSPENSION) BY BACTERIAL SUSPENSIONS IN PRESENCE OF 0·027 *M* $NaHCO_3$ AND A MIXTURE OF 95 PER CENT N_2 AND 5 PER CENT CO_2

	CO_2 uptake (cmm.) in 1 hr. at 37°C.
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate	0
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate + 0·2 ml. 1/1000 pyocyanine	60
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate + 0·2 ml. 1/1000 methylene blue	112
Suspension of 'propionic acid' bacteria + 0·017 *M*. acetate + 0·2 ml. 1/1000 β naphthoquinone sulphonate	88

Dr. D. M. Webley, in unpublished work carried out in this Unit, has found that washed suspensions of bacteria isolated from the soil bring about a rapid reduction of manganese dioxide so long as a suitable carrier (such as pyocyanine) and excess of hydrogen donator (in the form of nutrient) are present.

These facts show that the reduction of manganese dioxide can be accomplished either by bacterial masses in presence of their hydrogen donators and carriers, or by compounds, such as thiols or polyphenols, elaborated in the process of bacterial or plant metabolism or in the breakdown of soil organic matter. It follows that the reduction of manganese dioxide in soils is a process which may be accomplished entirely by biological means. Many species of bacteria may be involved in the reduction of the oxide of manganese, the determining factors being the supply, and nature, of the organic matter present.

Effects of Perfusing Glucose Through a Manganese-containing Soil

It follows from what has been stated that if there is present in soil an excess of a nutrient, which will serve as a hydrogen donator to the bacteria the growth of which it stimulates, or which breaks down to form compounds which will directly reduce manganese dioxide, the conditions will be favourable for the reduction of oxides of manganese in soil and hence for the appearance of divalent manganese. If the conditions are aerobic a dynamic equilibrium will be set up in which the rate of formation of divalent manganese by the biological reducing systems will be balanced by the rate of oxidation of this cation by the manganese oxidizing organisms present.

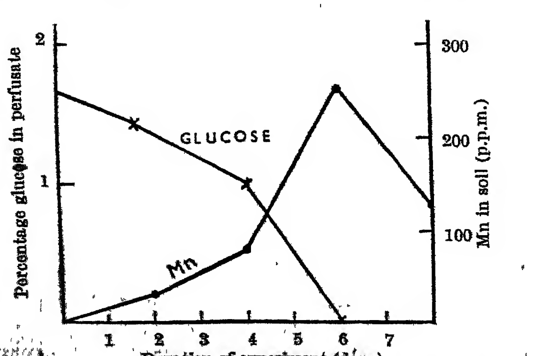

FIG. 2. EFFECTS OF PERFUSING GLUCOSE AT 70° F. ON EXCHANGEABLE (DIVALENT) MANGANESE OF ROTHAMSTED SOIL

The effect of perfusing glucose through a soil containing oxides of manganese is shown in the results given in Fig. 2*. It will be noted that the quantity of divalent manganese gradually increases so long as glucose is present in the system; when the glucose is entirely removed by bacterial activity the concentration of divalent manganese falls.

The effect of the addition of glucose to a soil on its divalent manganese content is seen more dramatically if sodium azide is also added to the soil. The azide retards the rate of oxidation of divalent manganese in soil much more than it retards the rate of reduction of oxides of manganese by soil bacteria in presence of glucose. The result is that glucose in presence of azide greatly enhances the concentration of divalent manganese in soil. A typical result is shown in Table 3.

TABLE 3.

EFFECTS OF GLUCOSE AND SODIUM AZIDE ADDITIONS ON DIVALENT MANGANESE FORMATION IN A ROTHAMSTED SOIL (20 GM.). DURATION OF EXPERIMENT = 44 HOURS AT 70° F.

Additions to air-dried soil	Divalent Mn formed (parts per million)
8 ml. water	5
8 ml. *M*/9 glucose solution	8
8 ml. 0·001 *M* NaN_3	13
8 ml. mixture of *M*/9 glucose solution + 0·001 *M* NaN_3	122

Manganese Cycle in Soils

It is clear from these results that manganese undergoes a metabolic cycle in soils, the kinetics of which is determined by the nature of the micro-organisms and the organic matter present. It appears from unpublished observations of Dion and Mann, in this Unit, that the first product of the biological oxidation of divalent manganese in soil is manganic oxide (Mn_2O_3) which, as was first shown by Meyer and Nehrlich, undergoes spontaneously a dismutation to divalent manganese and manganese dioxide, in accordance with the equation $Mn_2O_3 = MnO + MnO_2$. The velocity of this dismutation decreases rapidly with increase in *p*H, ceasing almost completely at *p*H 8·0.

The metabolic cycle undergone by manganese in neutral soils is summarized in Fig. 3.

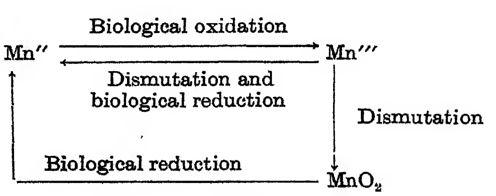

Fig. 3

The kinetics of the various phases of this cycle determine the rate of formation of divalent manganese at any time.

Full details of these and related experiments will be published in due course.

* Mn'' in soil was estimated by extraction of the soil with *N*$Ca(NO_3)_2$, (see S. G. Heintze, *J. Agric. Sci.*, 28, 175; 1938) followed by oxidation of the Mn'' in the extract by periodic acid to permanganate.

OBITUARIES

Prof. T. H. Laby, F.R.S.

The death of Prof. T. H. Laby, at the age of sixty-six, brings to an end the career of one devoted to the furtherance of physics and of science generally. His efforts in this direction, often in very difficult circumstances, undoubtedly undermined his health. Despite this, he was untiring in his work, the value of which to his native country, Australia, and to the world of science in general, is still inadequately recognized.

Laby was born in Victoria, Australia, and received his early academic education at the University of Sydney. After graduating, he was awarded an Exhibition of 1851 Overseas Research Studentship, and proceeded to Emmanuel College, Cambridge, and to research work at the Cavendish Laboratory under J. J. Thomson. After a successful period there, during which he held the Joule Studentship of the Royal Society, he took up an appointment as professor of physics at Wellington, New Zealand, in 1909. This he held until 1915, when he was elected to the chair of natural philosophy in the University of Melbourne, a post he retained until his resignation in 1942. His influence on Australian physics during this period was remarkable, and it is largely due to him that Australia holds a high place in the realm of physics.

Among the many reasons why Laby played such a unique part in the development of physics in Australia was his great interest in research and the wide range of his own activities in this direction. During his tenure of the chair, there existed throughout his department an air of enthusiasm and a feeling of complete confidence in the importance of the subject, which lent a distinction apparent to undergraduates as well as research students. This led to a remarkably regular production of very keen research students; so regular, in fact, that it was a matter of great surprise if, in any year, one of the Exhibition of 1851 Overseas Studentships did not fall to a member of Laby's department.

His primary interest was in precision experimental physics, but this did not prevent him from realizing the importance of other branches of the subject. Thus he was keenly aware of the importance of theoretical physics and encouraged any students with a bent in that direction. His unusual breadth of view is exhibited by his abolition of practical examinations in the subject, despite his own special interest in experiment.

It is difficult to say in which field of precise experiment Laby was most interested; thermal conduction, mechanical equivalent of heat, X-rays, geophysics, scientific radio all occupied his attention and were a continual source of research problems for his students and assistants. The precision determination of J by Laby and Hercus is well known, as are also the series of papers by Laby and by his assistant Kannuluik on problems of thermal conduction. Laby was actively interested in the work of the geophysical prospecting party, led by Broughton Edge in Australia, in 1929, and collaborated with Edge in editing the final report of the work, which is by way of becoming a standard text-book on the subject. Besides these researches in which he, personally, took an active share, Laby encouraged work on nuclear physics, and a neutron generator was in operation just before the War.

Among his publications the most widely used is undoubtedly the "Tables of Physical and Chemical Constants", compiled in collaboration with Dr. G. W. C. Kaye, and now in its ninth edition.

Apart from his academic activities, Laby played a very important part in official developments in Australian science, such as the organisation of the radium supply for hospitals and the formation and operation of the Radio Research Board. As a result of the latter, Australian workers have made, and are continuing to make, very important contributions to problems of radio transmission through the atmosphere. Despite all his other interests Laby maintained a detailed knowledge of developments in radio-physics. Thus, during his visit to England in 1934, he read to the Royal Society a stimulating paper by Martyn and Pulley, and was instrumental in exciting the interest of atomic physicists in ionospheric problems. He was thoroughly convinced of the importance of physics in the development of Australian industry, and devoted a great deal of time and effort towards the often thankless and wearisome task of convincing others of this now generally accepted fact.

At the outbreak of war in 1939, there existed virtually no optical industry in Australia to meet the requirements of optical munitions supply. Laby took a leading part in the organisation of the Optical Munitions Panel of Australia, of which he was the first chairman. This body was vital to the establishment of a sufficiently productive industry. Laby's real value in the war crisis cannot be measured only by this. The great contribution that Australian physicists were able to make to the defence of their country and of the British Commonwealth could not have been made if in preceding years a firm tradition of high-quality physics had not been established in Australia, largely by the efforts of the Department of Natural Philosophy at Melbourne under Laby's direction. The difficulties of doing this under conditions of isolation imposed by the great distance of Australia from Europe and America cannot easily be over-estimated, and there is no doubt that Laby sacrificed himself unsparingly in achieving this end.

H. S. W. Massey

Dr. Arthur W. Rogers, F.R.S.

On June 23 there passed away at Cape Town, at the age of seventy-four, one to whom South Africa owes much in regard to geological discovery, description and application. A. W. Rogers was born at Bishops Hall, Somerset, and educated at Clifton College and Christ's College, Cambridge—of which he was later elected an honorary fellow; he also studied at the University of Heidelberg.

In 1896 Rogers became assistant geologist to the Geological Commission of the Cape of Good Hope, director thereof in 1903, and director of the Geological Survey of the Union from 1916 until his retirement in 1932. His forty-three years of sterling service with the Government were divided equally between the Cape and Transvaal provinces.

Closely associated in the field at first with his colleague Prof. E. H. L. Schwarz, largely within the picturesque south-western corner of the Cape with its magnificent exposures of folded strata, he was able, by 1905, to publish "An Introduction to the Geology of Cape Colony", the first text-book of its kind for southern Africa, and a work of considerable

merit. In it were set forth the main tectonic lines, stratigraphy, palæontology and history of this interesting land with its many pre-Cambrian systems, Carboniferous glacials, prolific Permo-Triassic vertebrates and Mesozoic dolerites. During the next decade he carried investigation far to the north—to the border of the Kalahari and German territory—describing little-known pre-Cambrian groups or discovering new ones, such as the crocidolite-bearing jaspers, the Numees tillite, Ongeluk tillite, magmatic copper-bearing eruptives and melilite-basalts.

In the Transvaal, Rogers' main work lay in the mapping of the Heidelberg goldfields, during which the glacials of the Witwatersrand Beds were first recorded. Administrative duties greatly interfered with his output of purely scientific work. Under his able direction, however, a high standard was achieved by the Geological Survey, and numerous maps and memoirs issued, not a few of them of great economic importance.

Attracted, like so many others, by the vast Kalahari and its queer siliceous and calcareous rocks, he was able to cross its heart as well as inspect its borders, and contributed two illuminating addresses on the solid and surface geology of that sand-strewn region.

Always interested in the finer structure of substances, Rogers developed upon retiring to the Cape in 1932 a still keener interest in the microscopical and microchemical examination of the sedimentary rocks, a study which he pursued the more constantly after 1938, when ill-health had debarred him from further field work. To many of us such minuter researches proved helpful indeed.

Rogers' writings were numerous and varied: for the most part accounts of regional geology appearing as departmental reports or in yearbooks, or else as papers based thereon, though none was of monographic size. His most important works are "The Geology of the Country around Heidelberg", his contribution to the "Handbuch der Regionalen Geologie: The Union of South Africa" (1929) and his fascinating history of "The Pioneers in South African Geology and their Work" (1937), in which so much interesting geological as well as biographical information was so meticulously recorded for posterity. His presidential addresses cover a wider field, and range in their subjects from past climates to the evolution of river systems and 'pans'. Only just recently he completed a description of the diatom floras of the diatomaceous deposits of the Union in collaboration with L. E. Kent, intended for Memoir No. 42 of the Geological Survey, a research on which he had been long engaged.

In all, Dr. Rogers contributed both abundantly and nobly to our geological and geographical knowledge of a wide terrain, which I indeed regard as one of the key regions of the earth.

Connected with many learned societies, he was elected a fellow of the Royal Society of London (1918), the Geological Society of London (1896) and Royal Society of South Africa, as well as honorary fellow, member or correspondent of others. Rogers had been president of the Geological Society of South Africa (1915), of the South African Association for the Advancement of Science (1922), of the International Geological Congress (1929) and of the Royal Society of South Africa (1934–35). His awards were numerous: the Bigsby Medal (1907) and Wollaston Medal (1931) of the Geological Society; South African Medal (1913) of the South African Association for the Advancement of Science; Scott Medal (1931) of the Biological Society of South Africa, and Draper Memorial Medal (1936) of the Geological Society of South Africa. He received the degree of Sc.D. from Cambridge and an honorary degree of D.Sc from the University of the Witwatersrand.

Rogers will always be remembered for his geniality, readiness to discuss or guide, scrupulous attitude towards the work or views of others, and honesty of purpose. His outlook was, however, coloured by some conservatism. Throughout, he was the man of science pursuing his subject for its own sake, and perhaps for that reason the grander problems of the African continent do not seem to have gripped him. Having been closely associated with Arthur Rogers over many years, I feel that a noteworthy geologist has been lost to the world. Alex. L. du Toit

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We regret to announce the following deaths:

Dr. H. A. Colwell, known for his work on X-ray therapy and related subjects, on July 22, aged seventy.

Prof. J. Park, emeritus professor and formerly dean of the Faculty of Mining in the University of Otago, aged eighty-nine.

NEWS and VIEWS

Social Anthropology at Oxford: Prof. A. R. Radcliffe-Brown

Prof. A. R. Radcliffe-Brown, who is retiring from the chair of social anthropology in the University of Oxford, took a Cambridge degree in moral philosophy and studied anthropology as a post-graduate student under Haddon and Rivers, lecturing also occasionally for the London School of Economics. He started work in the field with a visit to the Andamans as Anthony Wilkin Student in 1906, but his book on "The Andaman Islanders", in its first form presented as a fellowship thesis at Trinity College, though finished before the First World War, was not published until 1922. By that time Radcliffe-Brown had been lecturing on anthropology at Johannesburg and was the first professor of social anthropology at Cape Town. From Cape Town he went as the first holder of a chair of anthropology at Sydney, and his foundation of a school of research and teaching at these two universities has perhaps been the most important contribution to anthropology of his career. His series of very important papers on Australian kinship systems, originally published separately in *Oceania*, have since been incorporated and published as a single volume. From Sydney he went to Chicago, again as the first professor of anthropology, so that his choice in 1937 to occupy a newly founded chair in social anthropology at Oxford was almost a foregone conclusion.

Prof. Radcliffe-Brown received the Rivers Memorial Medal of the Royal Anthropological Institute for research in the field in 1938; he was president of the Institute in 1939 and 1940; he was Frazer Lecturer in Cambridge in 1939; and he was Henry Myers Lecturer at the Royal Anthropological Institute in 1945. His contributions to anthropology in the form of researches on Australian kinship systems

would by themselves have been notable, but his influence on the development of teaching and research generally in both hemispheres has been still more important, and it is to be hoped that his activity in that direction is still far from concluded.

Mr. E. E. Evans-Pritchard

Mr. E. E. Evans-Pritchard, who has been appointed to succeed Prof. Radcliffe-Brown, studied anthropology under the late Prof. C. G. Seligman at the London School of Economics and is well known for his researches among the peoples of the Anglo-Egyptian Sudan carried out during 1926–36. The results of these studies have been published in a number of papers in *Sudan Notes and Records* and other scientific journals, and in two notable books, "Witchcraft, Oracles and Magic among the Azande" (1937) and "The Nuer" (1940). The scientific value of these works lies in the penetrating analysis applied to carefully observed facts. Mr. Evans-Pritchard was for a time professor of sociology at the Egyptian University, Cairo. He left Egypt to take up the position of research lecturer in African sociology in the University of Oxford. With Dr. Fortes he edited and contributed to a book on "African Political Systems" (see *Nature*, August 10, 1940). In 1939, Mr. Evans-Pritchard joined the Army and served in the Abyssinian campaign and later in Syria and in Cyrenaica. In the last-named country he was in close contact with the Senussi, on whom he has written several papers. On his return from the Army he was appointed reader in anthropology in the University of Cambridge. Cambridge now loses and Oxford regains one of the most brilliant of the exponents of what may be called the newer social anthropology, in which theories of social institutions are tested and developed by experimental observations in the field.

Chemistry at Royal Holloway College, University of London: Prof. T. S. Moore

Prof. T. S. Moore is retiring this summer from the chair of chemistry which he has held at Royal Holloway College since 1914. As a student he was first at East London College and then at Merton College, Oxford, and he became a fellow of Magdalen College, Oxford, in 1906. He worked in Oxford with N. V. Sidgwick on the rates of reaction of dyestuffs and in Germany with Hantzsch, and this training gave him an interest in both organic and physical chemistry and especially in the borderland between them. This interest is exemplified in his best-known work, the study of the basicities of the aliphatic amines (*J. Chem. Soc.*, **91**, 1373, 1379; 1907. Moore and T. F. Winmill, *ibid.*, **101**, 1635; 1912), in which for the first time the existence of undissociated amine hydrates in solution was demonstrated and their concentrations measured. Prof. Moore deserves well from all chemists for his valuable services to the Chemical Society. He was one of its secretaries during 1928–34 and served for years almost without number on the Publication Committee. He succeeded J. C. Philip as chairman of the latter in 1934, and it was here that his wide interests proved of such value. The difficulties of this position are well known; there are the interests—and sometimes the foibles—of the authors, the pressure on the space in the journal, the restricted funds. Moore's knowledge, human sympathies and charming manner enabled him to deal with these difficulties with great success. For this reason, but not for this reason alone, all will wish him many happy years of retirement.

Prof. Gwyn Williams

Dr. Gwyn Williams, who succeeds Prof. Moore, first graduated at the University College of North Wales, Bangor, under the late Prof. K. J. P. Orton, and was afterwards elected fellow of the University of Wales. After three years of research under Prof. Orton and Dr. F. G. Soper, he proceeded as a Strathcona research student to St. John's College, Cambridge, and for the next eight years worked in the laboratories of the late Prof. T. M. Lowry and Prof. E. K. Rideal. His wide experience has included two periods as a guest research worker in the research laboratories of the Eastman Kodak Company, Rochester, U.S.A. Since the beginning of the War he has been a member of the staff of King's College, London. A man of wide culture and varied interests Dr. Williams has also been active in the fields of adult education, student relief and assistance to refugee scholars from central Europe.

In his scientific work Dr. Williams, like his former chief Prof. Orton, has applied physical methods to the study of organic problems. In his earliest research on the chlorination of anilides he pointed out a significant generalization concerning the influence of polar substituents on reaction velocity. His studies have included gas and surface reactions and the kinetics of the polymerization of styrene. During the War he took a prominent part in the work on the kinetics and mechanism of nitration in sulphuric acid, carried out at King's College, which is only now being released for publication. This research has led to an important advance in our knowledge of aromatic nitration.

Dr. D. F. Twiss

Dr. D. F. Twiss, who has retired after thirty-two years as chief chemist to the Dunlop organisation, has played a great part in the scientific development of the rubber industry. Dr. Twiss has done a considerable amount of work on vulcanization with sulphur, and discovered the use of zinc isopropyl xanthate (Z.I.X.) as an accelerator of vulcanization. Another important discovery associated with his name is the use of metallic oxides, especially zinc oxide, in the presence of organic accelerators of vulcanization. Though now more than twenty years old, Dr. Twiss's theory of vulcanization is still one of the most useful. His suggestion is that the vulcanization of rubber with sulphur gives a rubber sulphide product which acts as a reinforcing agent for the rest of the rubber mass; and, since this material is actually formed in the rubber itself, gives a very effective type of reinforcement. He was a pioneer in the use of preserved rubber latex for the direct production of rubber articles. His earlier experiments led to the great industry in latex rubber, producing rubber thread of improved properties and self-ventilating sponge rubber with intercommunicating pores of controlled size. In 1934 the Institution of the Rubber Industry awarded him its highest honour, the Colwyn Gold Medal, for his scientific contribution to the knowledge of rubber. Before joining the Dunlop Rubber Company in 1914, Dr. Twiss was a lecturer in chemistry at Birmingham Technical School, now Birmingham Central Technical College; he was himself trained at Mason College, Birmingham, and was placed first on the roll of undergraduates when the college became the University of Birmingham. He holds research degrees of the Universities of London and Birmingham.

Cavendish Laboratory, Cambridge: The Austin Wing

In 1936, the gift by the late Sir Herbert (afterwards Lord) Austin was announced of a sum of approximately £250,000 for the work of the Cavendish Laboratory at Cambridge (see *Nature*, 137, 765; 1936). This enabled the University to proceed with a scheme of reconstruction of some of the laboratories, including a new building for the Cavendish Laboratory on the site of the old Zoological Laboratory. An imposing building, known as the Austin Wing, was erected in due course, and immediately taken over by the Government for war-time investigations. Now it has been released for its proper use, and was formally opened by Sir John Anderson on July 24. The Physical Society was holding an international conference, which was attended by seventy-five foreign guests, on "Fundamental Particles and Low Temperatures" in Cambridge during July 22–27, and the opening of the Austin Wing in the middle of the week fitted appropriately into the general programme.

The whole of July 24 was devoted to the Cavendish Laboratory; during the morning, papers dealing with current work in the Laboratory were read by E. S. Shire on nuclear physics, by W. H. Taylor on the X-ray analysis of various kinds of matter, by J. A. Ratcliffe on the work on radio carried out in the Cavendish and its outlying stations, by E. Orowan on the physics of metals, and by J. F. Allen on the Royal Society Mond Laboratory and its work on helium II and on magnetic phenomena. In the afternoon, a general meeting, under the chairmanship of the Vice-Chancellor of the University, was held in the Examination Hall; some four hundred delegates attending the Conference and members of the staff of the Cavendish Laboratory were present. Prof. J. D. Cockcroft gave a short history of the Austin gift and of the new building, after which the Vice-Chancellor introduced Sir John Anderson. Sir Lawrence Bragg thanked Sir John for his address, and presented him with a key with which to open the new building. After the formal opening, an inspection was made of the work in progress in the Austin Wing, the High Tension Laboratory and the Royal Society Mond Laboratory.

Hydro-electric Power and its Utilization

In these days when the world is talking of power from fissionable matter, one is apt to forget the inexhaustible nature of hydro-power. Hydro-power remains the only source of solar energy in which Nature herself seems prepared to undertake the tedious task of concentration; but the civil engineering works—dams, intakes, pipe-lines, canals and power-stations—are themselves engineering works of major importance. It already plays an important part in the industrial economy of the United States of America, where nearly half the potential sources are already tapped. Similar developments are impossible in Great Britain; catchment areas are too small, or they are too near sea-level. As our power-consuming processes expand, it is inevitable that they must be moved to areas where power now flows unharnessed. Except for the United States, only a tiny fraction of world-power is at present utilized; much is, of course, in places remote from industrial regions, but half the world is now within one-day journey, and fear of isolation need no longer deter labour from migration. It seems that big fields are open to those specializing in the design and construction of hydro-plant, and that a subsequent export trade of considerable magnitude would accrue to the country responsible for building the plant.

Anticipating a demand for suitably trained engineers, the English Electric Co., Ltd., under the chairmanship of Sir George Nelson, is actively stimulating the post-graduate study of hydro-power. Appropriate courses of advanced lectures and training in laboratory technique have been arranged at the Imperial College of Science and Technology in connexion with the Hawksley Hydraulic Laboratory under the direction of Prof. C. M. White, recently appointed to the new chair of fluid mechanics and hydraulic engineering. The English Electric Co. has placed the specialized knowledge of its technical staff at the disposal of the College and is contributing experimental equipment as well as a sum of £10,000 towards the initial expenses. The courses are open to students with honours degrees in engineering, and the subjects include fluid mechanics, river mechanics, model technique, hydraulic machines, hydrology, soil mechanics and concrete technology, together with their application to the design of the relevant hydraulic structures. Six English Electric bursaries of £200 a year are to be offered annually as an inducement to students who otherwise might hesitate to prolong an already long training; and various researches in progress in the laboratory at the outbreak of war are to be started again when students of the right type become available. Unfortunately, in this connexion much delay must result from the ruling of the Ministry of Education as to how entrants to the universities are to be selected.

A Second Giant Sunspot

For the second time this year, an exceptionally large sunspot has appeared. Coming over the sun's eastern limb on July 19–20, the centre of this giant spot crossed the central meridian on July 26–28 (passing 17° north of the centre of the disk) and was due to reach the western limb on August 2. In structure the spot is complex with several nuclei, and its area up to July 27 hovered around 4,000 millionths of the sun's hemisphere. Its predecessor in February had a mean area of about 4,300 millionths and a maximum area of 4,900 millionths—the largest sunspot group ever recorded at Greenwich.

A number of radio fade-outs on short-wave long-distance communication have been reported by Cable and Wireless Ltd. since July 20, and in several cases synchronous solar flares were observed in 6563 A. ($H\alpha$) at Greenwich and elsewhere. By far the most notable of these dual phenomena to date (July 27) was an intense solar flare commencing shortly after 16h. U.T. on July 25 and a long-continued fade-out beginning at 16h. 15m. This intense flare was observed at the Solar Physics Observatory, Cambridge, and by Dr. M. A. Ellison at Sherborne using his combined spectrohelioscope and spectrograph. The position of the flare, closely associated with the sunspot, was about 15° east of the central meridian and 29° from the centre of the disk, that is, within the central region of the disk known statistically to be favourable for a geomagnetic storm to occur about 24 hours after an intense flare. Ellison's observations indicate that the peak brilliancy was at about 16h. 29m., when the hydrogen line, $H\alpha$, in emission, had the abnormal width of 18 A. The aggregate area of the flare filaments was half that of the sunspot itself. The helium line, D_3, was also

visible over the area both in emission and absorption. According to preliminary information communicated by the Astronomer Royal, the expected geomagnetic storm—a 'great' one—began suddenly on July 26 at 18h. 46m. U.T., that is, $26\frac{1}{4}$ hours later. Up to 10h. on July 27, the ranges at Abinger in the three elements were: $1\cdot3°$ in declination; 900 γ in horizontal force and 560 γ in vertical force. An aurora was seen in Britain during the early hours of July 27.

Science Progress

WITH the July issue, *Science Progress* has reappeared after a lapse due to war-time difficulties. This well-known quarterly journal now has a more modern format, and the familiar green cover crowded with 'contents' has given place to a dignified buff cover containing the title and other essential bibliographical details only (London: Edward Arnold and Co. 7*s*. 6*d*. net). But although the outward form has changed, the general character of the journal has been retained, the contents consisting of general articles, notes on recent work in various branches of science, general notes, an essay review and shorter reviews. The first article is a lecture by Sir Charles Darwin on atomic energy; Sir Edward Salisbury writes on the reproductive capacity of plants, Mr. E. J. Bowen on physical states of aggregation, Prof. P. G. H. Boswell on geology in water supply, Mr. A. Armitage on John Flamsteed, Prof. E. D. Hughes on the Walden inversion, Mr. H. W. Lee on new optical glasses and Dr. G. S. Carter on mimicry and animal behaviour—fare for the most diverse interests. There will be a general welcome for *Science Progress* on its resumption of publication; with its general articles and surveys of scientific topics, it has taken an important part in recording and discussing scientific developments.

Transition of Neurotics from Army to Civilian Life

AN investigation has been made by Dr. Eric Guttman and Elsie L. Thomas in order to find out how men discharged from the Army on account of neurosis readjusted themselves to civilian life (Min. of Health Rep. Pub. Health and Med. Subjects. No. 93. London: H.M. Stationery Office. 1*s*. 3*d*. net). The conclusions reached revealed that they had great difficulty in so adjusting, and that even after fifteen months they had a high incidence of neurotic complaints and illness. This inability to adjust themselves was shown by delay in taking up work, in frequency of job-changing and in a high rate of sickness absence. Socially they were difficult, being less sociable and less active than previously. An interesting observation confirms the findings noted in the First World War, namely, that three-quarters of the men had serious neurotic traits before enlistment. The writers conclude that the early period after a man's discharge is the critical time, and hence this is when he should receive experienced psychiatric treatment and advice. The investigation revealed the inadequacy of the possibilities for such treatment, and the hope is expressed that with the return of psychiatrists from the Services there will be increased facilities for out-patient treatment.

British Guiana: Products and Development

A MEMORANDUM by Dr. F. Benham, economic adviser to the Comptroller for Development and Welfare in the West Indies, entitled "The National Income of British Guiana, 1942", has been issued as Bulletin No. 17 in the series "Development and Welfare in the West Indies" (Bridgetown, Barbados: Advocate Co., Ltd. Pp. 28. 10 cents). The tables and notes in this memorandum bring together facts and estimates of the value of production in British Guiana and cover agricultural, forest and mineral products, manufactures, public utility services, central and local government services, distribution of imports, rental value of houses, with summaries of production, imports and domestic exports. The national income for 1942 is estimated at 49,924,000 dollars, equal to about £28 15*s*. per head of population. The net value of production was 52,274,000 dollars and was swollen by an abnormally large output of bauxite and exceptionally high prices for local foodstuffs. More than ninety per cent of the population of 361,000 live on the narrow coastal belt of alluvial soil, many parts of which are below high-water sea-level and require an annual expenditure of millions of dollars on sea- and river-defence and on irrigation and drainage. Except for machinery replacements, this expenditure has not been deducted.

Carnegie United Kingdom Trust: Grants Scheme for Museums

IT is reported in the *Museums Journal* of January 1946 (p. 175) that the Trustees of the Carnegie United Kingdom Trust in drafting their plans for the period 1946–50 have set aside the sum of £30,000 for museum and art gallery development. Normally, grants will not exceed £750. Municipal and other museums (excluding the national institutions) which are members of the Museums Association and are open to the public will be eligible to make application. With certain reservations, the allotment of a grant generally requires that the museum in question (1) has an assured annual income normally equivalent to at least threepence per head of the population served, and (2) is, or will be, in the charge of a competent curator at an adequate salary. These terms are fair and commendable since they clearly aim at a general and all-round improvement of an important public service. Grants may be expended upon temporary professional and technical assistance, upon the training of recruits, upon the purchase of specimens necessary to fill in gaps in the sequence of exhibits, and upon such fittings (cases, etc.) as are essential to the scheme of reorganisation. They may not, however, be expended upon structural work on the main fabric of buildings.

George Westinghouse Newspaper Science Writing Award

IN honour of the centenary of George Westinghouse, founder of the Company, the Westinghouse Educational Foundation has provided funds for the award by the American Association for the Advancement of Science of awards for the encouragement of better science reporting in newspapers. The first annual George Westinghouse Newspaper Science Writing Award of 1,000 dollars will be made in December next "to the working newspaper man or woman judged to have written the best science story or series of stories this year". Entries submitted must have appeared in a newspaper, published in the United States or its territories, between October 16, 1945 and October 15, 1946 inclusive. Entry forms can be obtained from Dr. Willard L. Valentine, Editor of *Science*, Smithsonian Institution Building, Washington, 25, D.C., to whom they are to be returned under post-mark not later than midnight, October 20, 1946.

British Iron and Steel Research Association: Appointments

The following announcements have recently been made by the British Iron and Steel Research Association:

Mr. M. W. Thring has been appointed head of the Physics Department. Mr. Thring has been with the British Coal Utilisation Research Association for many years, and recently has been in charge of the Furnace Research Section and Combustion Research Laboratories. For the past eighteen months he and a large part of his team have been engaged on a co-operative research with Dr. J. H. Chesters and the United Steel Companies, Ltd., into the study of flames in furnaces; the 'down jet' method of combustion and the use of radon for studying gas flow in furnaces were originated by this team. Mr. Thring has also written papers on the laws governing energy flow in heating appliances, starting to form a link between Gibbsian thermostatics and industrial thermodynamics.

Dr. W. C. Newell, until recently on the staff of the Brown-Firth Research Laboratories, Sheffield, has been appointed head of the Steel Castings Division. Dr. Newell received his training and research experience at the Royal College of Science.

Mr. E. L. Diamond has been appointed mechanical engineer to the Plant Engineering Division. Mr. Diamond graduated in engineering with honours at King's College, London, in 1922, and then became a pupil of the late Sir Henry Fowler at the Derby locomotive works of the Midland Railway, later assisting in experimental work. Since 1926 he has been on the technical staff of the Institution of Mechanical Engineers, except during the war years. He has published a number of papers on technical locomotive problems.

Beit Memorial Fellowships for Medical Research

At a recent meeting of the trustees of the Beit Memorial Fellowships, it was announced that Sir John Anderson and Sir Henry Dale had been elected trustees; Lord Rayleigh and Lord Macmillan have resigned from the board. The Trustees noted with pleasure that Dr. E. B. Verney (fellow 1922–26) had been elected professor of pharmacology, Cambridge; Dr. Janet Vaughan (1931–34), principal of Somerville College, Oxford; Dr. B. G. Maegraith (1933–34), professor of tropical medicine, Liverpool; Dr. J. S. Mitchell (1934–37), professor of radiotherapeutics, University of Cambridge; Dr. R. J. Kellar (1935–37), professor of midwifery, University of Edinburgh; and that Dr. R. J. Hill (1929–31) and Dr. G. R. Cameron (1930–33) had been elected to the fellowship of the Royal Society.

The following elections were made: *Fourth Year Fellowships*. Dr. G. J. Popjak, to study the behaviour of plasma lipids under different experimental conditions and the problem of fœtal fat metabolism (at the Department of Pathology, St. Thomas's Hospital, London); Dr. Ethel G. Teece, to study the chemistry of bacterial polysaccharides and nucleoproteins with special reference to the Gram complex and to the factors responsible for cell division (at the Department of Chemistry, University of Birmingham). *Junior Fellowships*. Dr. S. E. Dicker, to study the extrarenal water metabolism and renal function in rats (at the Department of Pharmacology, University of Bristol); P. M. Tow, to study prefrontal leucotomy and the function of the frontal area (at the Research Department, Runwell Hospital for Nervous and Mental Diseases).

University of London

The following appointments have been announced:

Dr. Jaroslav Cerny, to the University chair of Egyptology tenable at University College as from October 1. During 1927–33 he worked in the Department of Antiquities, Egyptian Government; he accompanied the Harvard University Expedition to Sinai in 1935 and during 1942–45 he was in the Czech Diplomatic Service.

Dr. N. H. Fairley, to the Wellcome chair of tropical medicine tenable at the London School of Hygiene and Tropical Medicine as from October 1. He has been lecturer in clinical tropical medicine at the School and lecturer in tropical medicine at Westminster Hospital. During 1916–19 he was pathologist and later senior physician in the 14th Australian General Hospital; since 1942 he has been Director of Medicine to the A.M.F.

Dr. George Macdonald, to the University chair of tropical hygiene tenable at the London School of Hygiene and Tropical Medicine as from October 1. In 1939 he was appointed assistant director of the Ross Institute at the London School of Hygiene and Tropical Medicine, but he joined the R.A.M.C. and became officer commanding various malaria field laboratories in the Near and Middle East. During 1943–44 he was consultant malariologist to the Middle East and Central Mediterranean Forces, and in 1945 he was appointed director of the Ross Institute of the School.

Prof. J. T. Randall, to the Wheatstone chair of physics tenable at King's College as from October 1; since 1944, he has been professor of natural philosophy in the University of St. Andrews (see *Nature*, 156, 685; 1945).

Dr. R. M. Barrer, to the University readership in chemistry tenable at Bedford College as from October 1. During 1935–39 he was supervisor in chemistry and research fellow of Clare College, Cambridge, and since 1939 he has been head of the Chemistry Department at Bradford Technical College.

Mr. Edward A. Shils, to the University readership in sociology tenable at the London School of Economics from October 1. During 1942–44 he was in London on work in connexion with the Federal Communications Commission and SHAEF; he is at present associate professor of sociology in the University of Chicago.

Dr. F. C. O. Valentine, to the University readership in chemotherapy tenable at the London Hospital Medical College as from October 1. Since 1939 he has been pathologist, Emergency Medical Service.

British Association: New Officers

It is announced by the British Association that the following changes in office bearers have been approved by the General Committee: *President*, Sir Henry Dale, to succeed Sir Richard Gregory on January 1, 1947 (see *Nature*, July 27, p. 124); *General Officers* (with effect from July 20, 1946): *Treasurer*, Mr. M. G. Bennett, to succeed Sir Harold Hartley; *General Secretaries*, Dr. E. Hindle and Sir John Lennard-Jones, to succeed Prof. F. T. Brooks, Prof. D. Brunt and Prof. Allan Ferguson; *Secretary*, Mr. D. N. Lowe, to succeed Dr. O. J. R. Howarth.

Erratum. The author of a paper, referred to in *Nature* of March 9, p. 311, on the residual toxicity of D.D.T. to bedbugs, is incorrectly given as Miss Sarah Banks; the author is Dr. Sarah Barnes.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fission Products of U^{235}

THE first quantitative measurements on the formation of fission products in thermal neutron bombardment of uranium were made by Anderson, Fermi and von Grosse[1]. The fission yield of a fission isotope is the probability of the isotope being formed per thermal neutron fission. In bombardment, the rate of production of any active isotope from fission, that is, the fission rate multiplied by the fission yield, is equal to the disintegration rate of the active isotope referred to saturation of bombardment for the isotope. Thus data required for measurement of the fission yield of an active fission isotope are: (*a*) number of fissions occurring in a given sample per unit time; and (*b*) disintegrations per unit time of the isotope referred to saturation of bombardment.

Grummitt, Gueron, Wilkinson and Yaffe[2] determined the fission yields for Ba^{139} (86 min.), Ba^{140} (12·7 days) and La^{140} (40 hr.) produced in thermal neutron fission of U^{235}. The direct determination of fission rate in the bombarded sample was avoided by comparison of U^{239} (23 min.) and fission product β^- activities: accepting the ratio of the capture (σ_c) and fission (σ_f) cross-sections for thermal neutrons on natural uranium, the fission yield Y_f is given by the expression

$$\frac{U^{239}\text{ activity (referred to saturation of bombardment)}}{\text{Fission product activity (referred to saturation of bombardment)}} = \frac{\text{Thermal neutron capture rate}}{Y_f \times \text{thermal fission rate}} = \frac{\sigma_c}{Y_f \sigma_f}.$$

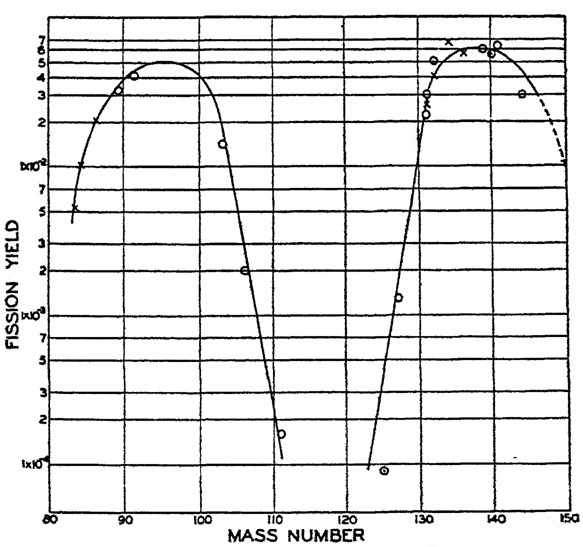
For Ba^{139} and La^{140}, values of $6·1 \times 10^{-2}$ and $5·8 \times 10^{-2}$ respectively were obtained. The fission yield for Ba^{140} was $4·3 \times 10^{-2}$. In the growth of La^{140}, from the parent Ba^{140}, 1·43 times as many La^{140} as Ba^{140} disintegrations were observed. Corrections were made for self-weakening of β^- rays in the samples, and for external absorption of β^- rays in the counting arrangement used. The latter was such that β^- rays of maximum energy below 0·1 Mev. were not observable. In subsequent work with the β^- ray spectrometer, L. G. Elliott[3] has shown that a large fraction of the electrons from Ba^{140} are below 32 Kev. These electrons would be completely stopped in the mica window of the counters used. If these are a low-energy β^- ray spectrum, and not conversion electrons, they would, of course, give rise to La^{140}, and could account for the observed growth of La^{140}. Further indication has been obtained using a windowless counter.

Fission yields of other fission isotopes can be obtained by activity comparisons to Ba^{140} in the same counting arrangements using the apparent or reference yield of $4·3 \times 10^{-2}$ for Ba^{140}. The longer-lived fission products of uranium have been studied by this method. If Y_i, A_i and Y_{Ba}, A_{Ba} are respectively the fission yields and activities (referred to saturation of bombardment) of any fission product i and Ba^{140}, then

$$Y_i = \frac{A_i}{A_{Ba}} \times Y_{Ba},\ \text{where } Y_{Ba} = 4·3 \times 10^{-2}.$$

Fission yields have been obtained in this way for twenty-two fission isotopes.

In the graph, the logarithm of the fission yield is plotted against the mass number of the fission isotope. In addition to the present results, fission yields for krypton and xenon isotopes of masses 83, 84, 86, 131, 132, 134 and 136 are included. These were obtained for mass-spectrographic determinations of isotopic abundances in fission product gases by H. G. Thode *et al.*[4], using as a reference the fission yield of I^{131} obtained by activity comparison to Ba^{140}, with the assumption that I^{131} decays directly to Xe^{131}.



FISSION YIELD *vs.* MASS NUMBER FOR THERMAL NEUTRON FISSION OF U^{235}

⊙, From activity comparisons

×, Calculated from mass-spectrographic abundance data for krypton and xenon

(*A*) Two symmetrical groups of fission products are formed with maxima at mass numbers 96 and 138 and a fission yield of $\sim 6 \times 10^{-2}$. The sum of the maxima is approximately 234, inferring that on the average, between one and three secondary neutrons are emitted per fission.

(*B*) The masses at a fission yield of 1×10^{-2} are 89 and 104 in the 'light group' and 130 and 151 in the 'heavy group'.

(*C*) The total of fission yields is 0·9 for each group. The divergence from unity is almost certainly due to a low value for the reference yield of Ba^{140}. A value of $4·8 \times 10^{-6}$ would remove the discrepancy and place the maxima at about $6·5 \times 10^{-2}$.

(*D*) The greater part of the heavy group lies in the rare earth region, and fission isotopes up to europium might be expected.

(*E*) After about 100 days, the measured gross activity of U^{235} fission products is accounted for by activities of the separated isotopes.

(*F*) Several previously unreported isotopes have been observed during the course of the present work, namely, $Sn^{>120}$ (136 days, 1·2 Mev.); $Sn^{>120}$ (17·5 days, 1·7 Mev.); $Sn^{>120}$ (7·0 days, 1·8 Mev.); $Sb^{(125)}$ (several years, 0·56 Mev.); $Sb^{>125}$ (28 days, 1·86 Mev.); $Cs^{(136)}$ ($\sim$ 20 days). Fission yields of these and the following β^- active isotopes were measured: Sr^{89} (54·5 days, 1·5 Mev.); Sr^{90} ($\sim$ 70 years, 0·6 Mev.), Y^{90} (72 hr., 2·2 Mev.); Y^{91} (61 days, 1·4 Mev.); Zr^{95} (65 days, 0·5 Mev.), Nb^{95} (33 days, 0·15 Mev.); Ru^{103} (37 days, 0·25 Mev.); $Ru^{(106)}$ (290 days), $Rh^{(106)}$ (30 sec., 3·3 Mev.); Ag^{111} (7·5 days, 0·9 Mev.); Sb^{127} (95 hr., 0·8 Mev.), Te^{*127} (90 days I.T.), Te^{127} (9·3 hours, 0·77 Mev.); Te^{*129} (32 days I.T.), Te^{129} (72 min., 1·5 Mev.); I^{131} (8·1 days, 0·6 Mev.); I^{132} (2·30 hr., 1·35 Mev.); $Cs^{(135)}$ ($\sim$ 100 years, 0·8 Mev.); Ba^{139} (86 min., 2·2 Mev.); Ba^{140} (12·7 days, 0·92 Mev.), La^{140} (40 hr., 1·4 Mev.); $Ce^{(141)}$ (18 days); Ce^{144} (290 days, 0·4 Mev.), Pr^{144} (17 min., 2·5 Mev.).

A detailed account of the experimental work is in preparation.

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June 1.

[1] Anderson, H., Fermi, E., von Grosse, A., *Phys. Rev.*, 59, 52 (1941).
[2] Grummitt, W. E., Gueron, J., Wilkinson, G., Yaffe, L., unpublished work (Montreal, 1944).
[3] Elliott, L. G., unpublished work (Montreal, 1945).
[4] Thode, H. G., Graham, R. L., Harkness, A. L., unpublished work (Hamilton, Ont., 1945).

Polyatomic Electronic Spectra: Further Analysis of the Vibrations of the $^1B_{2u}$ State of Benzene

IN a previous communication[1] we indicated how, in the example of the $^1B_{2u}$ state of C_6H_6 and C_6D_6, the product theorem and computations of force constants could be used to calculate or verify vibrational frequencies in electronically excited molecules. The discussion was almost entirely confined to the out-of-plane vibrations of both molecules, as insufficient experimental data were then available to permit calculations of the product ratios or force constants of the in-plane vibrations. It has now, however, been found possible to apply these methods to the in-plane vibrations, thus completing the first determination of a force system of an excited polyatomic molecule.

It was pointed out that Sponer's assignment of the frequencies 2565 cm.$^{-1}$ in C_6H_6[2] and 1821 cm.$^{-1}$ in C_6D_6[3] to the A_{1g}(H) vibration of the excited state, when combined with the known A_{1g}(C) frequencies, 923 cm.$^{-1}$ and 879 cm.$^{-1}$, of excited C_6H_6 and C_6D_6 respectively, was not in agreement with the product theorem. We now propose that the C_6H_6 progression previously regarded as

$$0-0 + 520\ (\overset{+}{E_g})' + 2565\ (A_{1g})' + \nu_1' \times 923\ (A_{1g})'$$

and the corresponding C_6D_6 progression

$$0-0 + 499\ (\overset{+}{E_g})' + 1821\ (A_{1g})' + \nu_1' \times 879\ (A_{1g})'$$

should be formulated

$$0-0 + 3085\ (\overset{+}{E_g})' + \nu_1' \times 923\ (A_{1g})'$$

and $$0-0 + 2320\ (\overset{+}{E_g})' + \nu_1' \times 879\ (A_{1g})' \text{ respectively.}$$

The frequencies 3085 cm.$^{-1}$ in C_6H_6 and 2320 cm.$^{-1}$ in C_6D_6 are assigned to the $\overset{+}{E_g}$ (H-stretching) vibration of the excited state. The frequencies of the same vibration in the electronic ground-state are 3047 cm.$^{-1}$ in C_6H_6 and 2264 cm.$^{-1}$ in C_6D_6. The assignment thus implies that the hydrogen-stretching force constant is higher in the excited state than in the ground-state, unlike other force constants, which we find to be reduced as a result of excitation. If the electron which is excited is one of the π-electrons then it seems plausible, not only that forces involving deformations of C−C bonds should be reduced, but also that the C−H bonds may slightly increase their order at the expense of the weakened ring system, with the result that the hydrogen-stretching constant becomes increased.

An immediate consequence is that the A_{1g}(H) frequencies should be raised. Consistent values are obtained from the hitherto unassigned progressions

$$0-0 + 520\ (\overset{+}{E_g})' + 3130\ (A_{1g})' + \nu_1' \times 923\ (A_{1g})'$$

in the absorption spectrum of C_6H_6 and

$$0-0 + 499\ (\overset{+}{E_g})' + 2361\ (A_{1g})' + \nu_1' \times 879\ (A_{1g})',$$

in that of C_6D_6. The frequencies 3130 and 2361 cm.$^{-1}$ are assigned to the A_{1g}(H) vibration of the excited state. The product ratio,

$$\Pi A_{1g}(C_6H_6)'/\Pi A_{1g}(C_6D_6)' = 923 \times 3130/879 \times 2361 = 1·392,$$

is in satisfactory agreement with the ground-state value 1·404.

Confirmation of this idea has been forthcoming in the analysis of the electronic spectra of several partly deuterated benzenes. In 1 : 3 : 5-$C_6H_3D_3$, the excited state frequencies, 3138 cm.$^{-1}$ and 2337 cm.$^{-1}$, can be assigned to A_1'(H) and A_1'(D) vibrations respectively. The corresponding values for the ground-state are 3053 cm.$^{-1}$ and 2282 cm.$^{-1}$ [4]. Perhaps the strongest argument is that, in the absorption spectrum of 1 : 4-$C_6H_4D_2$, the progression corresponding to the C_6H_6 progression $0-0 + 3085 + 923\ \nu_1'$ is doubled, while that corresponding to the C_6D_6 progression $0-0 + 2320 + 879\ \nu_1'$ remains single; whereas, in the spectrum of 1 . 2 : 4 : 5-$C_6H_2D_4$, the former progression is single and the latter double. In C_6H_6 and C_6D_6, Sponer assigned the frequencies 3085 and 2320 cm.$^{-1}$ to a combination of an $\overset{+}{E}_g$(C) and an A_{1g}(H) vibration, whereas we have assigned them to a fundamental $\overset{+}{E}_g$(H) vibration. For $C_6H_4D_2$ and $C_6H_2D_4$ the distinction follows that, whereas Sponer's view would permit only the two A_g hydrogen-stretching vibrations to start progressions, our analysis additionally allows the related B_{1g} vibration to give the extra progression which in each case is observed. A summary of the ground- and excited-state frequencies (in cm.$^{-1}$) of the A_{1g}-, B_{1u}- and $\overset{+}{E}_g$-like hydrogen-stretching vibrations of some isotopic benzenes is given below.

State	D_{6h} Sym.	C_6H_6	C_6D_6	D_{3h} Sym.	$C_6H_3D_3$	V_h Sym.	$C_6H_4D_2$	$C_6H_2D_4$
Ground	B_{1u}	3060	2290	A_1'	2282			
Excited		3138	2337		2337			
Ground	A_{1g}	3062	2293		3053	A_g	2280	3045
Excited		3130	2361		3138		2353	3132
Ground	$\overset{+}{E}_g$	3047	2264				3055	2285
Excited		3085	2320				3085	2356
Ground		3047	2264			B_{1g}	3042	2272
Excited		3085	2320				3077	2334

In 1 : 3 : 5-$C_6H_3D_3$ two main progressions are observed. One, in 893 cm.$^{-1}$, corresponds to the A_{1g}(C) progression, 923 cm.$^{-1}$ in C_6H_6, and 879 cm.$^{-1}$ in C_6D_6. The other, in 987 cm.$^{-1}$, corresponds to the B_{1u}(C) vibration, which in C_6H_6 and C_6D_6 cannot produce progressions; but, as modified in $C_6H_3D_3$, can do so. The frequencies 893 and 987 cm.$^{-1}$ belong to the A_1' class of $C_6H_3D_3$ vibrations, and, from these and other known frequencies, we can, using the product theorem, calculate, for the inactive B_{1u}(C) frequencies of excited C_6H_6 and C_6D_6, the values 1001 and 948 cm.$^{-1}$ respectively.

Sklar, Sponer, Nordheim and Teller have determined the frequencies of the two E_g(C) vibrations of excited C_6H_6 and C_6D_6 [2,3], and we have dealt above with the $\overset{+}{E}_g$ (H-stretching) vibration. The frequencies of the $\overset{+}{E}_g$ (H-bending) vibration are identified through the observed progressions $0-0 + 1045 + 923\ \nu_1'$ of C_6H_6 and $0-0 + 775 + 879\ \nu_1'$ of C_6D_6. The frequencies 1045 and 775 cm.$^{-1}$ must belong to vibrations having $\overset{+}{E}_g$ symmetry, and we have assigned them to the $\overset{+}{E}_g$ (H-bending) vibration. The resulting product ratio,

$$\Pi\overset{+}{E}_g(C_6H_6)'/\Pi\overset{+}{E}_g(C_6D_6)' = 1\cdot965,$$

compares well with the ground-state value 1·967. Further confirmation arises from assignments in the A_g class of 1 : 4-$C_6H_4D_2$ and 1 : 2 : 4 : 5-$C_6H_2D_4$ vibrations.

Wilson's potential function for benzene contains four in-plane force constants, which may be considered as denoting C-stretching (F), H-stretching (f), C-bending (D), and H-bending (d) [5,6]. The C_6H_6 and C_6D_6 frequencies which are now available for the calculation of these constants for the excited state of benzene are listed below, together with the corresponding ground-state frequencies and the percentage changes which accompany electronic excitation.

Vibration	C_6H_6 Ground	C_6H_6 Excited	% change	C_6D_6 Ground	C_6D_6 Excited	% change
A_{1g}(C)	992	923	−7	943	879	−7
A_{1g}(H)	3062	3130	+2	2293	2361	+3
B_{1u}(C)	1010	1001	−1	963	948	−2
B_{1u}(H)	3060	3138	+2	2290	2337	+2
$\overset{+}{E}_g$(C1)	606	520	−14	577	499	−14
$\overset{+}{E}_g$(C2)	1596	1476	−8	1551	1408	−9
$\overset{+}{E}_g$(H1)	3047	3085	+1	2265	2320	+2
$\overset{+}{E}_g$(H2)	1178	1045	−11	867	775	−11

Some force constants (in 10^5 dynes/cm.), calculated from these frequencies using Kohlrausch's form of Wilson's equations, are listed below, together with the ground-state values calculated from the same equations. The constants F and f were calculated from the A_{1g} frequencies, while D and d were obtained from the B_{1u} and $\overset{+}{E}_g$ frequencies.

		F	f	D	d
C_6H_6	ground	7·6	5·0	0·77	0·60
	excited	6·5	5·3	0·56	0·45
C_6D_6	ground	7·6	5·1	0·82	0·57
	excited	6·5	5·3	0·57	0·46

These constants cannot be regarded as more than provisional, and are given to indicate the approximate amounts by which force constants change as a result of electronic excitation. It is interesting to note the smaller changes in these in-plane force constants, as compared with reductions of the out-of-plane constants by 50 per cent or more[1].

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June 22.

[1] *Nature*, **157**, 46 (1946).
[2] *J. Chem. Phys.*, **7**, 207 (1939).
[3] *J. Chem. Phys.*, **8**, 705 (1940).
[4] *J. Chem. Soc.*, 256 (1946).
[5] *Phys. Rev.*, **45**, 712 (1934).
[6] *Z. Phys. Chem.*, **30**, 307 (1935).

Topography of Crystal Faces

IN *Nature* of May 4, Tolansky and Wilcock[1] report various features of the topography of the face of a diamond crystal, and conclude that the triangular pits often seen on the faces are due to growth, not to solution: a layer, spreading across the crystal face, does not at first cover a particular region but grows all round it, afterwards closing in on it from three directions to form a triangular pit. We wish to report that, in observing certain crystals growing from solution, we have often seen this sort of thing actually happening—not of course on diamond, but on crystals of water-soluble substances, notably potassium dihydrogen phosphate. The layers we have seen, since they are easily visible under the microscope, are much thicker than those seen by Tolansky and Wilcock on diamond. Two further points are worth mentioning. One is that these pits are often irregular in shape; this is natural enough when the advancing edges of the layers are irregular, as is the case more often than not when growth is rapid. Irregular pits found on finished crystals may therefore be due to growth, no less than regular ones. The second point is that the pits often become completely filled in, there being afterwards no visible trace of their existence.

With regard to the stepped pyramids seen by Tolansky and Wilcock on diamond, we have seen similar features on a number of crystals, again on a much larger scale. Two photographs showing examples of this are shown in a recently published book by one of us[2]. Layers of octagonal shape have been seen on crystals of sodium chloride; hexagonal layers are sometimes seen on cadmium iodide, but the shape is more often nearly circular. On octahedral faces of lead nitrate crystals, the layers are roughly triangular, but tend to have rounded or irregular edges. The thickness of the layers varies greatly with the conditions of growth, and is profoundly affected by the presence of certain impurities. Usually layers spread from a single point, roughly in the centre of a crystal face: but we have occasionally seen more than one system of layers on the same face, each spreading from a different point. On most of the crystals we have observed, the layers are much thinner near the centre than towards the edge of a face; thin layers, spreading more rapidly than thicker ones, can sometimes be seen overtaking lower layers, thus adding to their thickness. It seems likely that a process of this kind—the building of thick layers from thinner ones—goes on, right down to the ionic scale. A system of submicroscopic layers would constitute a low pyramid of vicinal faces, and the curvature of vicinal faces mentioned by Tolansky and Wilcock may well be connected with a gradual change of layer thickness from the centre of a face towards the edges.

A more detailed account of this work will be published elsewhere.

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[1] Tolansky, S., and Wilcock, W. L., *Nature*, **157**, 583 (1946).
[2] Bunn, C. W., "Chemical Crystallography" (Clarendon Press, 1945).

A Convenient and Efficient Fractionating Column and its Use in the Separation of the Heavy Isotopes of Hydrogen and Oxygen

THE performance of a fractionating column recently constructed and used in this Department prompts us to place on record its chief characteristics. The column is packed with miniature (1/16 in.) Θ-shaped 'rings' of phosphor-bronze gauze (100 mesh) and is enclosed in a vacuum jacket containing multiple, concentric aluminium reflectors. The length of the packed section is 12 ft. and its internal diameter is

20 mm. The column is supported on a specially designed 'grid'. The 'grid' is a three-sided structure of metal piping built in the centre of a small laboratory, so that all points outside and inside the ⊔-shaped assembly are easily accessible. The whole structure acts as a convenient supporting device, and the various metal pipes from which it is constructed serve to bring the usual services (gas, inlet and exit water) to numerous points suitably spaced for serving different types of fractionating columns and other items of equipment. The 'grid' also supports a large slate switchboard, from which all the electrical services can be controlled, and 'hard' and 'soft' vacuum lines are included in the assembly.

For the enrichment of the heavy isotopes of hydrogen and oxygen by the fractionation of water, the 'boiler' used was a 750 ml. glass vessel which was charged with 500 ml. of water and heated by internal electrical heaters. The total condensate was delivered into a full reservoir (containing 20 litres of water) from which an identical quantity of water was returned to the top of the column through a small pre-heater. After twenty-four days of continuous distillation, we obtained 500 ml. of water which was 200 parts per million heavy in deuterium and 350 parts per million heavy in O^{18}. We have not yet had the opportunity of running the column to equilibrium, and thus to determine its platage, but we estimate from our preliminary results for the enrichment of O^{18} after various times, using the vapour pressure data of Wahl and Urey[1], that the efficiency of the unit is equivalent to about 450 theoretical plates for a boil-up rate of 500 ml. of water per hour.

Up to the present we have operated this type of column at atmospheric pressure, but experiments under reduced pressure are in hand. The column has been running almost continuously, day and night, for weeks, requiring no attention, various automatic safety devices and controls having been incorporated. The importance of fractionating columns of this degree of efficiency cannot be overstressed, particularly in connexion with the separation of isotopes and the close fractionation of mixtures of organic compounds.

Work on the design of efficient laboratory fractionating columns and their use in the separation of isotopic and other mixtures is continuing; our detailed results will be published elsewhere.

We are indebted to Dr. M. P. Applebey and Imperial Chemical Industries, Ltd., Billingham Division, for advance information concerning their metal gauze packing and distillation technique, and to Mr. T. R. Jacobs for most valuable assistance in the construction of the apparatus.

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[1] *J. Chem. Phys.*, 3, 411 (1935).

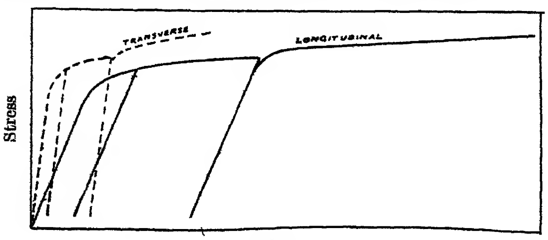
'Plastic' Transverse Contraction of a Longitudinally Strained Metal

SOME experimental work has been done to examine the parameters in my theory of stress-strain relationships beyond the yield point of metals[1]. This theory includes the classical equations of elasticity as a particular case. The total strain in a specimen under simple tensile loading is called 'inelastic' and divided into the two idealized components 'elastic' and 'plastic'. When load is removed, the elastic strains disappear, but the plastic strains remain. Attention was directed in the theory to the importance of the ratio of the transverse to the longitudinal plastic or permanent deformations in the simple tensile test of the metal considered. The ratio

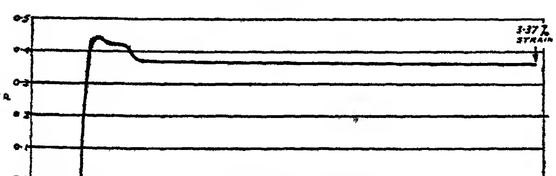
$$p = \frac{\text{Transverse plastic strain}}{\text{Longitudinal plastic strain}}$$

was given the value ½ because it was stated that the plastic part of the inelastic strain would occur at constant volume in the absence of evidence to the contrary. The present experiments were designed to correct this deficiency in our knowledge. The well-known Poisson's ratio is that of the transverse to the longitudinal elastic strains.

Measurements of strain were made with Baldwin *S.R.*4, 120 ohms, ½-in. gauge-length orthogonally crossed *AX*5 electric resistance wire



Strain



Longitudinal strain

strain-gauges stuck to a duralumin simple tensile specimen with 'Duco Household Cement'. The specimen had a working section 4 in. × 1½ in. × ¼ in. An optical extensometer of 2¼ in. gauge-length spanned longitudinally over the electric gauge and its readings were used to calibrate the Baldwin gauges.

The ratio p was found to reach a maximum value 0·42 at the corner of the stress-strain curve and then drop quickly to a constant value 0·37 up to the maximum longitudinal strain 3·37 per cent, at which the electric strain-gauge wire broke. This value 0·37, instead of the ideal ½, indicates that volume changes *do* occur in the plastic component of the strain as well as in the elastic part. Further tests will be made to check this value and to find the value for other materials than duralumin.

It is suggested tentatively, as a result of the few tests available up to the present, that p will have a value appropriate to each material tested. When giving the properties of metals for use by designers, it will be necessary to state p as well as Poisson's ratio q for use in a stress analysis.

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[1] *Phil. Mag.*, July 1945.

The Mass of the Universe

ONE of the comparatively few points of similarity in current cosmological theories is the occurrence in each of a parameter of mass of the order of 10^{55} gm., equivalent to about 10^{79} protons. In Eddington's cosmology this parameter is fundamental; and in Milne's, although he assumes that the world is infinite, there appears a similar constant[1] which he calls the 'fictitious mass of the universe'. This common feature in theories otherwise so different suggests that there may be a less sophisticated method of derivation, possibly within the framework of classical mechanics, the far-reaching cosmological applications of which were first pointed out by Milne[2] and McCrea[3] and have since been emphasized by Heckmann[4].

It is well known that the classical formula for the *gravitational* energy of a homogeneous sphere of mass M and radius R is

$$V = \frac{3GM^2}{5R}, \quad . \quad . \quad . \quad . \quad (1)$$

where G is the constant of gravitation. In general, this is very much smaller than the *inertial* energy assigned by Einstein,

$$E = Mc^2, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where c is the velocity of light.

According to Mach's principle, the inertia of a body is due to the background influence of the whole physical universe. According to Einstein's principle of equivalence, gravitation is akin to inertia. Thus, the gravitational background influence of the whole universe should be equivalent to its inertial influence. Formula (1), however, is derived on the assumption that we can neglect the gravitational influence of all matter other than that constituting the sphere in question. Presumably this omission accounts for, or at least accentuates, the great numerical discrepancies between (1) and (2) (a crude calculation for the earth gives $E \sim 10^9 V$, and for the sun $E \sim 10^6 V$): but, if it is legitimate to regard a certain homogeneous 'sphere' as a first approximation to the universe 'in the large', then for such a body we should expect the discrepancy, if any, to be much less. Hence, if we tentatively assume that, for our model universe,

$$E = V, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

we find that its mass and radius must be related by the law,

$$M = \frac{kc^2R}{G}, \quad . \quad . \quad . \quad . \quad (4)$$

where $k = 5/3 \sim 1{\cdot}67$. This law can also be obtained by a simple dimensional argument, assuming that the constant of gravitation is determined by c, R and M only; but k cannot be determined in this way.

It is remarkable that formula (4) is identical with the corresponding formula connecting the mass and radius of the Einstein universe, except that, in the latter case, $k = \pi/2 \sim 1{\cdot}57$. Thus the crude estimate given by (4) lies within about six per cent of the precise value for the mass of the Einstein universe of the same radius. The latter, of course, has a non-Euclidean metric.

Furthermore, if following Milne we substitute in (4) the relation,

$$R = ct, \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where t is approximately 2×10^9 years, we immediately obtain his well-known formula[5],

$$M = \frac{c^3t}{G}, \quad . \quad . \quad . \quad . \quad . \quad (6)$$

except for an extraneous factor 5/3; hence, in Milne's case, $k = 1{\cdot}00$.

In all three cases, if R is of the same order of magnitude as ct, M is of the order of 10^{55} gm. or 10^{79} protons. This figure cannot be compared directly with observation, but nebular counts provide an estimate for the local density, ρ. According to Hubble[6], this is not greater than about 10^{-29} gm./cm.^{3}, but this figure must be regarded as provisional and may have to be increased. In Milne's model, space is Euclidean; consequently,

$$M = \frac{4}{3}\pi\rho R^3, \quad . \quad . \quad . \quad . \quad (7)$$

and hence Milne's predicted value of ρ is of the order of 10^{-27} gm./cm.[3] On the other hand, in the Einstein universe, which is the basis of Eddington's system, space is hyperspherical; consequently,

$$M = 2\pi^2\rho R^3. \quad . \quad . \quad . \quad . \quad (8)$$

With the value assigned by Eddington to the Einstein radius of space, ρ is again of the order of 10^{-27} gm./cm.[3], but at the present epoch of expansion Eddington considered that the radius is about five times[7] the Einstein radius, giving ρ of the order of 10^{-29} gm./cm.[3].

Hence, rival theories assign numerically different values for the local density distribution. Nevertheless, they agree in isolating mass parameters of the same order of magnitude. As a tentative physical explanation of this theoretical phenomenon, it is suggested that 10^{55} gm. is the *order* of mass which a homogeneous and spherically symmetrical continuous material system must possess if: (i) its gravitational potential energy is comparable with its inertial potential energy; and (ii) its radius is of the *order* of 2×10^9 light-years.

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Cascade Showers under Thin Layers of Materials

IN a previous paper, Bhabha and Chakrabarty[1] discussed the general theory of the production of cascade showers. The solution obtained there was finally evaluated by the saddle-point method, and it was shown that the same expression cannot be used for small values of t and y_0, where t is the thickness of the material in radiation units and y_0 is log (E_0/β), where E_0 is the energy of the primary particle and β is the critical energy for the material. Consequently in that paper numerical values were obtained only for values of $y_0 \geqslant 3$ and $t \geqslant 2$.

It can be seen, however, that $P(E,t)dE$, which represents the number of particles (electrons and positrons) having energies between E and $E + dE$ (produced by a primary particle of energy E_0) at a depth t below the surface of the material, is *exactly* given by

$$P(E,t) = \frac{1}{2\pi i}\int_{\varkappa - i\infty}^{\varkappa + i\infty} e^{rt}dr \cdot \frac{1}{2\pi i E_0}\int_{\sigma - i\infty}^{\sigma + i\infty}\left(\frac{E_0}{E}\right)^s$$

$$\left\{\sum_{n=0}^{\infty}\left(-\frac{\beta}{E_0}\right)^n \cdot \frac{\Gamma(s)}{\Gamma(s-n)} \prod_{i=0}^{n} \frac{D+r}{(r+\lambda_{s-i})(r+\mu_{s-i})}\right\} ds, \quad . \quad (1)$$

where λ_s, μ_s are functions of s (see ref. 1). For convenience in calculations, we can express (1) in the form

$$P(E,t) = \frac{1}{2\pi i}\int_{\varkappa - i\infty}^{\varkappa + i\infty} e^{rt}dr \,.$$

$$\frac{1}{2\pi i E_0}\int_{\sigma - i\infty}^{\sigma + i\infty}\left(\frac{E_0}{E + \beta g(s,r)}\right)^s f(s,r,\beta)ds. \quad . \quad . \quad (2)$$

where

$$f(s,r,\beta) = f(s,r) - \frac{\beta}{E_0}f_1(s,r) + \left(\frac{\beta}{E_0}\right)^2 f_2(s,r) -$$

$$\left(\frac{\beta}{E_0}\right)^3 f_3(s,r) + . \quad . \quad (3)$$

and $g(s,r)$ is to be so chosen as to make the series (3) rapidly convergent. It can be shown that if we take

$$f_0(s,r) = \frac{D+r}{(r+\lambda_s)(r+\mu_s)}, \text{ and } g(s,r) = f_0(s+1, r),$$

then by taking only the first term $f_0(s,r)$ in place of $f(s,r,\beta)$ in (2), we get practically the whole of $P(E,t)$; and this is particularly so for smaller values of t. We therefore have, to a very high degree of accuracy,

$$P(E,t) = \frac{1}{2\pi i}\int_{\varkappa - i\infty}^{\varkappa + i\infty} dr \,.$$

$$\frac{1}{2\pi i E_0}\int_{\sigma - i\infty}^{\sigma + i\infty} e^{rt}\left(\frac{E_0}{E + \beta g(s,r)}\right)^s \cdot \frac{D+r}{(r+\lambda_s)(r+\mu_s)}ds. \quad (4)$$

The integral in (4) can be evaluated by the saddle-point method for *all* values of t and y_0, and as such is an improvement on the solution given in ref. 1. Hence if exp $\psi(s,r)$ represents the integrand of (4), then

$$E_0 P(E,t) = \frac{1}{2\pi}\left[\exp\psi(s_0,r_0) \cdot \left\{\frac{\partial^2\psi}{\partial r^2} \cdot \frac{\partial^2\psi}{\partial s^2} - \left(\frac{\partial^2\psi}{\partial r\partial s}\right)^2\right\}^{-1/2}\right]_{\substack{s = s_0, \\ r = r_0}} \quad . \quad (5)$$

where s_0 and r_0 satisfy the equations $\dfrac{\partial\psi}{\partial r} = 0 = \dfrac{\partial\psi}{\partial s}$, simultaneously.

The total number of particles $N(t)$, at any depth t in the shower-producing layer, can be easily obtained from (4). The values of $N(t)$ thus obtained for some different values of y_0 and t are given in the accompanying table.

VALUES OF $N(t)$ FOR A PARTICLE EXCITED SHOWER

t \ y_0	1	2	3	4	5	6
0·2	1·12	1·20	1·27	1·34	1·40	1·48
0·5	1·15	1·50	1·84	2·18	2·51	2·85

Janossy and Tzu[2] have suggested that the solution given by Bhabha and Chakrabarty[1] can also be used for smaller values of t, provided we retain also the term containing exp $(-\mu_s t)$ occurring there in the integrand. That this is not so will be evident when the values of $N(t)$ for $t = 0·5$ and $0·2$ are obtained from that expression. For smaller values of E_0 which are interesting from the practical point of view, the error comes to about 40 per cent for $t = 0·5$ and to 100 per cent or more in the case of $t = 0·2$.

With the above solution it is now possible to deduce the energy spectra of the shower particles at all thicknesses and for all energies of the primary particle.

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[1] Bhabha and Chakrabarty, *Proc. Roy. Soc.*, A, **181**, 267 (1943).
[2] Janossy and Tzu, *Nature*, **157**, 624 (1946).

Turbulent Flow in Alluvium

SEVERAL years ago, I put forward[1] two original equations for the flow of water in alluvium: the first for the wetted perimeter P in terms of the discharge Q, the second for the mean velocity V in terms of the hydraulic mean depth R and water surface slope S. Both expressions had the curious characteristic that they appeared to be independent of the grade of alluvium transported. They may be written in general terms

$$P = \text{`}x\text{'}Q^{1/2} \quad . \quad . \quad . \quad . \quad (1)$$

$$V = \text{`}y\text{'}R^{2/3}S^{1/3} \quad . \quad . \quad . \quad (2)$$

The equations were empirical and derived from a mass of hydraulic data. Their simplicity gave cause for the hope that eventually a dynamic theory to justify them would be evolved, and basic dimensionally homogeneous equations for the turbulent flow of water in alluvium derived. In this connexion the following analysis is fruitful.

From equation (1)

$$(RV)^2 = Q/x^2.$$

From equation (2)

$$V^5 = y^3(RV)^2S.$$

Eliminating (RV), which is a proportional to the Reynolds number,

$$S = x^2V^5/y^3Q \,; \quad . \quad . \quad . \quad (3)$$

or, on introduction of 'g' the acceleration due to gravity,

$$S = KV^5/g^2Q, \quad . \quad . \quad . \quad (3a)$$

in which the coefficient is given by the equation

$$K = g^2x^2/y^3 \quad . \quad . \quad . \quad . \quad (4)$$

Equation (3a) is dimensionally homogeneous, and the coefficient K must be either a pure number or a pure number multiplied by one or more dimensionless numbers to a very low power, and of insufficient weight to affect the approximate constancy of the coefficient K. The computed value of K is clearly of great moment.

In 1930 I assigned a value of 2·67 to 'x' and of 16·1 to 'y'. In 1937 the Punjab Irrigation Research Institute[2] confirmed my equation (1) from a more extended range of observations and assigned to 'x' the value of 2·80. Other observations on other collections of data have given values of 'x' ranging from 2·5 to 3·0. The Punjab collection is more authoritative. My latest value of 'y' is 16·0. It would not appear possible from observations on canals to obtain values of these coefficients with an error of less than 5 per cent. If for 'x' a value of 2·81 is taken, and for 'y' a value of 16·0, 'g' being given a value of 32·2, the value of K as computed from equation (4) is precisely the round number 2. The question immediately arises whether this is a pure number. The following theorem which I have derived enables us to arrive at a tentative conclusion on this point.

If we consider the horizontal and vertical axes of an ideal asymmetrical alluvial channel cross-section, W can be taken as a length characterizing the effective width of the channel, and D a length characterizing the effective depth. The intersection of the axes at the centre of the water surface may be regarded as the polar origin of generation of the channel section by the turbulent water flowing with a discharge of Q. There are thus two lengths involved, $\frac{1}{2}W$ and D.

The first dimensionless number, involving the width is, I suggest, a new Froude number $V^2/\frac{1}{2}gW$.

The second dimensionless number, involving the depth, is none other than the familiar V^2/gDS.

These two numbers on correlation give the original equation

$$V^2/\tfrac{1}{2}gW \quad = \quad gDS/V^2 \quad . \quad . \quad . \quad (5)$$

In this expression W and D are appropriate measures of the width and depth, subject to the restriction that their product is equal to the cross-sectional area of the channel. The wetted perimeter and the hydraulic mean depth are not of necessity the best variables to employ in alluvial channels with the greater part of the transported load on or near the bed. In the sequel, whether W and D are employed, or, alternatively P and R, equation (5) on transformation gives the new equation for turbulent alluvial flow

$$S \quad = \quad 2V^5/g^2Q \quad . \quad . \quad . \quad (6)$$

As soon as any attempt is made to introduce the size of the silt particle into this equation, dimensional difficulties will arise; nor can the difficulty be entirely overcome by employing, as Dr. C. M. White has suggested[3], the terminal velocity of the alluvial particle in still water, V_S, as a measure of grade.

If, however, we introduce (VS) the vertical component of the mean velocity as a criterion, all difficulties are removed. Thus

$$S \quad = \quad 2^{1/6}(VS)^{5/6}/(g^2Q)^{1/6} \quad . \quad . \quad (6a)$$

This equation should be compared with the empirical equation of Dr. Bose[2]

$$S \quad = \quad 0{\cdot}00209\, m^{0{\cdot}85}/Q^{0{\cdot}21},$$

in which m is the diameter of the bed sand in millimetres.

The criterion (VS) is basic, as it is a proportional to the rate of dissipation of energy by unit volume of the water, and is also linked with the terminal velocity of the alluvial particles.

It must be emphasized that equation (6) can apply rigidly only to an active turbulent alluvial channel flowing uniformly in an ideal unlimited incoherent medium of the same grade, or range of grades, as the material transported. The amount of the load, the grade, the degree of scouring or silting are all implicit in the energy criterion (VS). It remains to examine the numerical coefficient K and to ascertain from rigid analysis whether it is a pure number as I believe it to be.

It is hoped that this brief note may encourage other workers in this field, and prove of assistance to those who contemplate initiating original researches in the subject of turbulent alluvial flow.

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[1] Lacey, G., *Proc. Inst. Civ. Eng.*, 229 (1930); 237 (1934).

[2] Bose, Annual Report of the Punjab Irrigation Research Institute, Lahore (1937).

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MR. GERALD LACEY has discussed the dimensions of rivers flowing in beds of incoherent alluvium and gives certain relations connecting their speed, width, depth, slope and discharge. I find his steps difficult to follow because I do not know which of the variables he regarded as dependent and which independent. Without such definition, there is the risk that one may derive two empirical formulæ which look different but which do in fact state the same thing though containing different errors of field measurement. On algebraically combining two such formulæ one could prove anything.

In broad outline, there appear to be four basic independent factors which together define a river; they are: (1) the rains, and area of catchment; (2) the gravitational field causing the flow; (3) the physical properties of the rock or soil of the catchment; (4) the physical properties of the water. To this list could be added the slope, S, in the case of rivers which have not yet completely cut their own channels, but strictly speaking, in the case of old rivers, where erosion and building has settled down to some stable cycle, the slope is determined by the four factors above and S is not an independent.

The first problem is how to represent these four quantitatively: (1) may be represented well enough by the flow Q $[L^3/T]$ at 'bank-full' stage; (2) is $g[L/T^2]$; (3) and (4) can perhaps be described by the resulting flow of subdivided solids: the particle size in relation to the physical properties of the water is described approximately by the terminal speed, V_S $[L/T]$, of a typical particle, while the quantity of solids flowing is conveniently expressed as a fraction N of the water flow. Here then are four measurable quantities to represent the four independents.

In 1939 I directed attention[1] to the possibility that Q, g, V_S, and N served as four independents the values of which might together determine river dimensions, and suggested that of the possible dependants, the cross-sectional area $a[L^2]$ of the resulting channel, reckoned up to bank-full level, was easy to measure at any time of the year, and not sensitive to local peculiarity. This dependant a can be reduced to a pure number in several ways; the simplest is to divide it by $Q^{4/5}/g^{2/5}$; here Q and g are arbitrarily chosen, but their exponents 4/5 and 2/5 are the only values which can satisfy dimensions. Expressed thus as a pure number the dependant is

$$\frac{ag^{2/5}}{Q^{4/5}},$$

and its value lies between 3 and 10 for most rivers at bank-full stage. With regard to its dependence on Q, g, V_S and N, the last, the ratio of solids to water, is already a pure number, and the other three can form only one dimensionless group, namely,

$$\frac{g^{2/5}Q^{1/5}}{V_S}.$$

Assuming the list of independents to be complete, then there is no alternative but to expect $ag^{2/5}/Q^{4/5}$ to be a function of the two numbers $g^{2/5}Q^{1/5}/V_S$ and N.

Therefore I examined data for a typical selection of rivers in which N probably lay between 1/1,000 and 1/5,000, but the flows of which varied over a range as great as 10^6, and found that the cross-sectional areas of all at bank-full stage could be represented by

$$\frac{ag^{2/5}}{Q^{4/5}} \;=\; 2{\cdot}4\left(\frac{g^{2/5}Q^{1/5}}{V_S}\right)^{0{\cdot}22} \;\pm\; 20 \text{ per cent} \quad . \;\; \mathrm{W}(1)$$

valid for $5 < g^{2/5}Q^{1/5}/V_S < 2{,}000$. The slope of these same rivers was given, though with some diffidence, since other factors may be involved, as

$$S \;=\; 0{\cdot}012\left(\frac{V_S}{g^{2/5}Q^{1/5}}\right)^{0{\cdot}9} \;\pm\; 50 \text{ per cent} \quad . \;\; \mathrm{W}(2)$$

Other dependants such as the ratio of width to depth P/R, or the ratio meander-wave-length to depth, are also readily expressed by similar formulæ.

It is significant that Mr. G. Lacey's formulæ 1 and 2 were based on data quite other than those I used. He now combines them into a group similar to my $ag^{2/5}/Q^{4/5}$ and his resulting formula 3a (with his new constants) is

$$\frac{ag^{2/5}}{Q^{4/5}} \;=\; 1{\cdot}15S^{-1/5} \quad . \quad . \quad \text{G. Lacey } (3a)$$

Here he probably regards slope as an independent fixed by geographical and geological factors rather than by the cutting of the river. However this may be, $S^{1/5}$ as given by my formula W2 is

$$S^{1/5} \;=\; 0{\cdot}41\left(\frac{V_S}{g^{2/5}Q^{1/5}}\right)^{0{\cdot}18} \quad . \quad . \mathrm{W}(2a)$$

and inserting this (the kind of step not permissible algebraically; but in the present instance only a low power of S is being used, and the resulting expression is not going to be further manipulated), L3a becomes:

$$\frac{ag^{2/5}}{Q^{4/5}} \;=\; 2{\cdot}8\left(\frac{g^{2/5}Q^{1/5}}{V_S}\right)^{0{\cdot}18},$$

which only differs from my W1 by the factor $0{\cdot}86\left(\frac{g^{2/5}Q^{1/5}}{V_S}\right)^{0{\cdot}04}$, the value of which over the whole practical range lies between 1 and 1·2, and river data are not so exact as this. Incidentally, my formula W1 is for rivers; straight canals are stable when their areas are 20 per cent less than W1, which further reduces the difference since the data used by Lacey in determining the constants in his original formulæ included many canal measurements.

So, numerically, formulæ W1 and L3a agree, though the particular way in which Lacey writes 3a eliminates bed material from the formula. That he can do so is no proof that bed material is unimportant; rather, he treats bed material as if it were dependent and slope as independent. From the practical point of view, rivers can play havoc when their slopes are in process of changing, and in connexion with the regulation of rivers we need information as to the ultimate slope towards which they are tending, so that we can plan our works accordingly. There is little we can do to make rivers adopt some other slope, and S is best treated as a variable dependent on the hydrological and geological data. We may make the river behave itself when we short-circuit a piece of it, but our success is not because we have imposed an increased slope on it; rather we have hastened its approach to that slope which gives equilibrium.

The Punjab data, as represented by Dr. Bose's formula,

$$S \;=\; 0{\cdot}00209\;\, m^{0{\cdot}85}Q^{-0{\cdot}21}$$

within the ranges to which it relates is also not inconsistent with my W2. So it seems that the channels cut by very complicated actions in which solids are conveyed by rivers with erodible beds are consistent with the simple picture I gave involving only four independent variables: this simplification does at least provide some sort of framework on which to hang the field data, and it is not grossly in error when tested numerically. I think this justifies the assumption about the four variables, one of which, V_S, is a gross simplification, and Mr. Gerald Lacey is correct in regarding it as faulty; but a better one has not yet been found.

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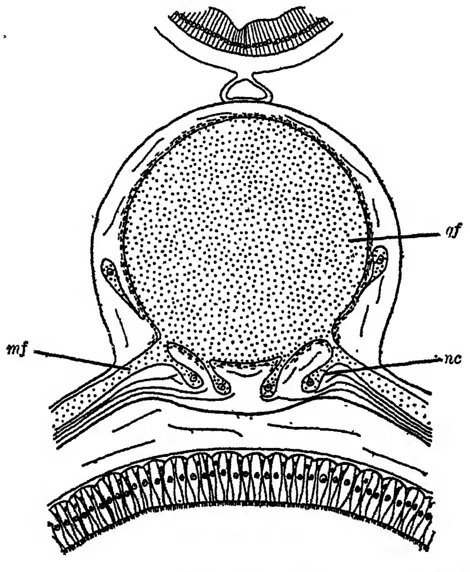
[1] White, C. M., *Proc. Int. Union Geod. Geophys.* (Washington, 1939).

Giant Nerve Fibre of *Myxicola infundibulum* (Grube)

MANY of the Annelids possess relatively large nerve fibres in their central nervous system, and those of the earthworm among the Oligochætes, and of *Halla*, *Arenicola*, *Clymenella* and *Axiothea* among the Polychætes, have been studied. The giant fibres in these forms arise either from a single nerve cell in the case of *Halla*[1], or each fibre from numerous nerve cells in the case of the other forms mentioned[2]. According to several writers[3], the single nerve fibre in the ventral nerve cord of the Sabellid, *Myxicola infundibulum*, is exceptionally large and we have, therefore, prepared serial sections of this species.

The fibre is truly giant, attaining up to 1 mm. in diameter, greatest in the thorax and anterior abdomen and tapering to about 100 μ in the posterior extremity. It thus compares favourably with the giant nerve fibres of the Cephalopods, *Sepia* and *Loligo*[4]. It extends throughout the length of the ventral nerve cord, lying dorsally to the nerve cells and neuropil and constituting the major part of the cord (*gf*). In spite of its large size, it appears as a single nerve fibre consisting of a uniform mass of axoplasm with faint longitudinal striations but no transverse or longitudinal subdivisions.



TRANSVERSE SECTION OF THE VENTRAL NERVE CORD OF *Myxicola infundibulum* IN THE THORACIC REGION. *gf*, GIANT FIBRE; *mf*, MOTOR BRANCH; *nc*, NERVE CELL BODY. × 33

Anteriorly, in the first few thoracic segments, both the ventral nerve cord and its contained giant fibre bifurcate, forming two discrete cords with a giant fibre in each. Transverse commissures connect the two halves of the cord together, and anastomoses between the two giant fibres occur in each of these commissures. The two fibres unite again in the sub-œsophageal ganglion, and a branch passes up through each of the circum-œsophageal connectives into the supra-œsophageal ganglia. Here the branches from either side connect with one another in the lower part of the supra-œsophageal ganglia.

By employing buffered solutions of silver nitrate[5], it has been possible to impregnate the nerve cells and smaller fibres and reveal some of the connexions of the giant fibre. Numerous unipolar nerve cells (*nc*) send their processes into the giant fibre in each segment. Larger motor branches (*mf*) proceed peripherally in the segmental nerves to the strongly developed longitudinal musculature.

The sheath of the giant fibre is composed of a fine network of fibrils, forming a dense investing envelope distinct from the collagenous sheath of the nerve cord. The sheath does not blacken on treatment with osmium tetroxide, indicating the absence of any appreciable amount of myelin. Nuclei occur throughout the thickness of the sheath.

One of the most characteristic behavioural reactions of this animal is the sudden shortening which can be induced by mechanical stimulation of any part of the body. Following section of the cord, isolated ends of the animal still showed this quick contraction in specimens observed for sixteen days. Sections of the giant fibre either anterior or posterior to the injured region showed no histological signs of degeneration, corroborating the observation that the cell bodies of the giant fibre occur along the length of the cord. The giant fibre thus constitutes a unique example of a final common path produced by fusion of the processes of many nerve cells, so that afferent impulses from any part of the body are directed into a single effector unit and activate all the longitudinal muscle fibres of the body. The whole living nerve cord can be removed from the body, but it has not proved possible to obtain a stretch of giant fibre free from cord and investing sheath. Action potentials obtained from a dissected cord show that the giant fibre, like those of the squid, though a syncytium, yet acts as a single functional unit.

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Origin of the First European Potatoes and their Reaction to Length of Day

MR. HAWKES[1] has stated, with reference to the first European potatoes, that "*S. andigenum*, although mainly short day in photoperiodic reaction, does possess certain day neutral and even long day clones. . . . If, by any chance, one of these was introduced into Europe, then there would be no reason at all why it should not have yielded well from the very first." Recently, he and Mr. Driver[2] stated in *Nature*: "There is no reason why the original short-day forms from the Andes could not maintain themselves under European conditions though giving a reduced yield. This is what happens when the recently collected Andean forms are grown under the longer days of Great Britain." In both quotations the underlying idea is that the first European potatoes would have been at a disadvantage as regards yield, if they had been short-day in reaction. This idea is substantially the same as that of Russian workers. It is not supported by the evidence, as I have already pointed out[3], but it is very prevalent and further comment seems desirable.

One need consider only Spain and the British Isles, typical representatives of the countries where the potato was first widely grown as a crop. It was suggested[3] that in Spain potatoes were grown as an autumn crop; and if they yielded badly, it was at least no fault of a short-day reaction. In the British Isles, the west in particular, potatoes could be, and were, grown deep into the autumn, November being a popular harvesting date. Here potatoes seemingly made good use of the conditions; haulms grew during summer, when conditions are optimal for haulm growth, and tubers probably grew mostly after the approach of autumn, when conditions are optimal for tuber growth. For it is fairly clear from experiments on photoperiodism that the rate of production of tubers by unit mass of haulm is greatest in short days, and the physiological efficiency of short days has often been pointed out before.

What has happened during the course of the centuries in Britain, and north-western Europe generally, is that there has been a shift from autumn tuber-growth to summer tuber-growth. (The shift, of course, is not complete.) The result may be more convenient to modern farmers, but there is no evidence of greater yields, at least in the absence of blight. One grants that the best yields should be given by varieties which use both the summer and the autumn, and admits that varieties like Epicure and Arran Banner make remarkable use of long days, but in view of the evidence of photoperiodism it would be rash to assume that breeders could not have made as good use of the short days of autumn. Any tendency towards satisfaction with modern achievements should be tempered by the reflexion that average potato yields have not risen in Britain during the last 100–150 years[4], despite a vast amount of research in all directions. Although many early varieties existed at the beginning of last century, the impression one gets is that the shift from autumn to summer tuber-formation had not yet gone so far as it has now, and it would be interesting to know to what extent autumn growth has determined not only the early history and geography of the potato in Europe but also the yield. Unfortunately, there is little evidence about this. Even with the Andean potatoes no attempts to ascertain yields in Europe in autumn have been published. Research has centred around the determination of photoperiodic response. Hackbarth[5] was so concerned with the difference between long and short days that he did not see fit to record the dates of planting and harvesting or whether the maturity was early or late, but one infers that the plants were mature before the autumn equinox. In the experiments at Cambridge the potatoes were planted early and all surviving plants harvested on September 30—most lines matured before then—to prevent the possibility of increased yield in short autumn days, a procedure which was necessary for the particular purpose of the experiment. No doubt many—perhaps most—of the Andean varieties are poorly bred and inherently weak yielders under any conditions of length of day; but it must be admitted that workers in Europe have made their adaptation seem worse than it is by growing them during a season to which they are least adapted and which differs from that in which the first European potatoes were grown.

To change the topic in conclusion, an explanation about the Basutoland potatoes seems called for. Readers of the recent communication by Mr. Hawkes and Mr. Driver might assume that I believe that all these potatoes have an extreme short-day response. This is not the case. Several varieties mature early; and if they, and other European early varieties of the first part of last century, were not discussed in my original communication[3], it was because they are irrelevant to the point which was being argued.

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[4] See editorial comment, *Gardeners' Chronicle*, Jan. 12 (1946). Yields in Lincolnshire at the end of the eighteenth century are discussed by Wallace in Bull. 94, Min. Agric. Fish. England (1941).
[5] *Züchter*, 7, 95 (1935).
[6] Driver, C. M., and Hawkes, J. G., Bull. Imp. Bur. Plant Breed. and Genet. (1943), 36.

THE point at issue between Dr. van der Plank and ourselves seems to be whether the Andean short-day potatoes were or were not at a disadvantage when brought to Europe in the late sixteenth century. We have stated that we consider they were at some disadvantage[1], at any rate in Great Britain, where they would normally have been cut down by frost before maturity. Although occasionally we have been able to leave some of our *S. andigenum* varieties in the field so late as November 26, even then they were far from being mature, nor was the yield so high as was obtained from commercial varieties under similar conditions. Under such conditions the potato plants would have been subjected to short days for at least ten weeks, but possibly the temperature and light intensity at that time of the year were unsuitable for rapid tuber development. The experiment to which Dr. van der Plank makes reference[2] was conducted under glass and hence is scarcely referable to the point at issue.

What would have happened in Ireland where frosts are late or only slight we do not know, since no tests have been carried out in the south-west; and in any event the incidence of blight might now obscure the issue. For Dr. van der Plank to state, therefore, that the Andean potatoes would not have been at a disadvantage when grown in Ireland in the early seventeenth century is pure supposition, since there is not a single piece of evidence to support this view. Evidence of high yields in England was not available until about two hundred years later, by which time some breeding and selection had no doubt taken place.

Whatever may be Dr. van der Plank's opinion, we still feel ourselves perfectly justified in maintaining that the extreme short-day reaction of most of the Andean potatoes was an undesirable feature, and one which had to be removed before the potato crop could assume the importance it has to-day. It might be mentioned that while both Andean potatoes and European varieties have hereditary capacities for high yield, in the former case the greatest single limiting factor under British conditions is the day-length requirement, while in the latter case cultural conditions and disease play a greater part. Nevertheless, the yield obtained from the early introductions would be by no means negligible, but would be sufficient to encourage their culture as soon as farming conditions became suitable.

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[1] *Nature*, 157, 591 (1946).
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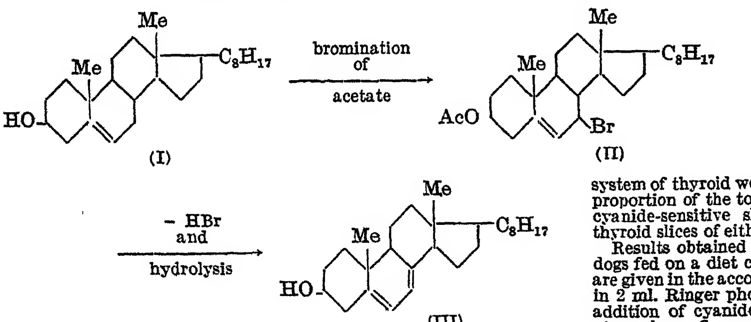
A New Route to 7-Dehydrocholesterol, Provitamin D_3

In 1935, Windaus, Lettré and Schenck[1] described the preparation from cholesterol (I) of 7-dehydrocholesterol (III), which on irradiation gave a highly antirachitic product (vitamin D_3), later[2] shown to be identical with the naturally occurring vitamin D isolated from tunny liver oil. The original route to provitamin D_3, giving an overall conversion from cholesterol of about 4 per cent, has since been employed for the synthesis of several related dehydrosteroids[3], but it has not been materially improved, although some useful minor modifications have been described[4]. Claims[5] have been made for alternative and improved methods, but, so far as we are aware, none of these has proved entirely satisfactory.

We have now discovered that the reaction of N-bromosuccinimide[6] or related compounds with cholesteryl acetate gives a product from which '*β'-7-bromocholesteryl acetate* (II) (m.p. *c.* 105–110°; $[\alpha]_D^{20°}$ —245° in chloroform) can be isolated. On heating this monobromo compound with diethylaniline, hydrogen bromide is eliminated;



(I) (II) (III)

after hydrolysis of the product, 7-dehydrocholesterol (III) can be isolated, either by chromatography or as its readily purified 3:5-dinitrobenzoate. Under suitable conditions, cholesterol can be converted by this route into its 7-dehydro-derivative in yields of about 30 per cent.

Detailed accounts of this process, of its application to other steroid derivatives, and of the characterization and reactions of the 7-bromosteroids, will be published elsewhere[7].

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[4] Haslewood, G. A. D., *J. Chem. Soc.*, 224 (1938). Wintersteiner, O., and Ruigh, W. L., *J. Amer. Chem. Soc.*, 64, 1177 (1942).
[5] For example, Milas, N. A., and Heggie, R., *J. Amer. Chem. Soc.*, 60, 984 (1938). Mazza, F. P., and Migliardi, G., *Chem. Abstracts*, 37, 3762 (1943)
[6] Ziegler, K., *et al.*, *Ann.*, 551, 80 (1942).
[7] See also B.P. 574,432.

Antithyroid Drugs and Cytochrome Oxidase Activity

Schachner, Franklin and Chaikoff[1] found that the *in vitro* formation of diiodotyrosine and thyroxine by thyroid slices, using radioactive iodine, I^{131}, as indicator is inhibited by cyanide, azide, sulphide and carbon monoxide (particularly in the dark). This indicates that the cytochrome oxidase system is involved in the synthesis of thyroxine by the thyroid gland. Franklin, Chaikoff and Lerner[2], using the same technique, showed that thiourea and thiouracil in a concentration of 10^{-3} *M* inhibited the *in vitro* synthesis of diiodotyrosine and thyroxine.

It has been repeatedly suggested that thiourea and thiouracil exert their antithyroid effect by inhibiting the cytochrome oxidase system in the thyroid gland. Paschkis, Cantarow and Tillson[3], determining cytochrome oxidase activity colorimetrically with *p*-phenylene diamine as substrate, found that 0·002 *M* thiouracil added to thyroid tissue *in vitro* inhibited the oxidase activity significantly. They also found a significant decrease in the oxidase activity of the thyroids of adult rats fed thiouracil in the drinking water for 11–21 days. They state, however, that after several months treatment, the oxidase activity of the thyroids increases, approaching normal values. Stotz, Sidwell, and Hogness[4] consider *p*-phenylene diamine to be not very suitable as a substrate for measuring cytochrome oxidase activity since its potential is so low that it is also oxidized by cytochrome *b*. Keilin and Hartree[5], moreover, emphasize that results obtained using colorimetric methods for assessing cytochrome oxidase activity should be accepted with reserve unless corroborated by measurements of oxygen uptake.

The conclusion that thiouracil exerts its effect on the thyroid by inhibiting cytochrome oxidase activity is not supported by results obtained in these Laboratories.

The cytochrome oxidase activity of horse heart muscle preparations prepared according to Keilin and Hartree[4] has been determined using hydroquinone, ascorbic acid and *p*-phenylene diamine as substrates, the oxygen uptake being measured at 37° C. over a period of 30 minutes in Warburg manometers. When hydroquinone and ascorbic acid were used as substrates, the activity was unaffected in the presence of a total concentration of 0·03 *M* thiourea, 0·03 *M* 2:aminothiazole or 0·003 *M* thiouracil, even if the enzyme preparation was previously incubated with the drug for several hours. Using *p*-phenylene diamine as substrate, however, the above concentration of thiouracil inhibited the activity 28–41 per cent. Thiourea and aminothiazole had no effect. Mann and Keilin[6] have shown that sulphonamides, which also possess antithyroid activity, do not inhibit cytochrome oxidase activity, although Paschkis, Cantarow and Tillson[3], using the procedure described above, found 30 per cent inhibition in the presence of 0·001 *M* sulphadiazine.

Since a large proportion of the total respiratory exchange of all organs is effected through the cytochrome oxidase system, the respiration-rate of tissue slices should be reduced by a substance which inhibits cytochrome oxidase activity. The respiration-rate of slices of horse, dog and rat thyroids, however, is not affected by the addition of thiourea (0·02 *M*) or thiouracil (0·005 *M*). Moreover, the respiration-rate of diaphragm and liver slices from rats fed 0·5 per cent thiourea or 0·1 per cent thiouracil in the diet for several months is not significantly different from that of control animals. (The Q_{O_2} of thyroid slices from these rats is considerably greater than that of the controls, due presumably to an increase in the proportion of the cellular components in hyperplastic rat thyroids.)

If the activity of the cytochrome oxidase system of thyroid were inhibited by feeding thiourea or thiouracil, the proportion of the total respiratory exchange of thyroid slices which is cyanide-sensitive should be decreased. This is not the case with thyroid slices of either rats or dogs fed thiouracil.

Results obtained with thyroid slices from one control dog and two dogs fed on a diet containing 0·1 per cent thiouracil for eight months are given in the accompanying table. The thyroid slices were suspended in 2 ml. Ringer phosphate solution at *p*H 7·4, with and without the addition of cyanide, and the oxygen consumption measured in an atmosphere of oxygen at 37° C. in Warburg manometers over a period of 60 minutes. When *p*-phenylene diamine was used as substrate, 0·2 ml. of 0·2 *M* *p*-phenylene diamine adjusted to *p*H 7·4 was introduced into the side bottle and tipped into the main bottle at the end of the first 60-minute period. The oxygen consumption was then measured for a further 60 minutes.

RESPIRATION-RATE OF THYROID SLICES FROM CONTROL AND THIOURACIL-TREATED DOGS

Diet	No added substrate	In presence of 0·002 *M* sodium cyanide		In presence of 0·018 *M* *p*-phenylene diamine	
	Q_{O_2}	Q_{O_2}	% inhibition	Q_{O_2}	% of original value
Control	−3·93	−2·35	40	− 8·7	221
Thiouracil	−6·90	−4·35	37	−14·9	216
	−5·73	−3·22	44	−11·7	204

These results show that the degree of inhibition of the respiration-rate in the presence of 0·002 *M* sodium cyanide is not markedly different for thyroid slices from control and thiouracil-fed dogs. The ability to oxidize added *p*-phenylene diamine is also not interfered with by feeding thiouracil.

Moreover, thiouracil (0·005 *M*) added to slices of horse and dog thyroids does not inhibit the rate of oxidation of *p*-phenylene diamine or ascorbic acid: in fact, in the case of horse and dog thyroid slices, the rate of oxidation of *p*-phenylene diamine is increased some 35–67 per cent.

These results support the view that the prevention of thyroxine synthesis in the thyroid by thiourea and thiouracil is not due to inhibition of cytochrome oxidase activity.

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[6] Mann, T., and Keilin, D. *Nature*, **146** 164 (1938).

Grignard Compounds as Condensing Agents

IN connexion with the communication on this subject by Hickinbottom and Schlüchterer[1], we think it would be of general interest to record similar observations made in and since June 1945 in the course of work on hydrocarbon syntheses for the Institute of Petroleum.

We have found that the interaction of *iso*propylmagnesium bromide and methyl*iso*butylketone gives a considerable yield of 2 : 4 : 8-trimethylnon-4-en-6-one

$$(CH_3)_2CH.CH_2.C(CH_3) = CH.CO.CH_2.CH(CH_3)_2$$

but no appreciable quantity of methyl*iso*butylcarbinol. The same ketone is produced in much smaller yield by the action of *iso*butylmagnesium bromide on methyl*iso*butylketone, the main by-product in this case being methyl*iso*butylcarbinol.

A more interesting observation was that both this ketone and methyl*iso*butylcarbinol were formed by the action of *iso*butylmagnesium bromide on methyl acetate, indicating that free methyl*iso*butylketone is probably an intermediate in this reaction.

At the moment, insufficient data are available to permit of a decision on the relation between structure of reactants and proportion of normal reaction, reduction reaction and condensation reaction. The *type* of branching at the carbon atom to which the magnesium atom is attached in the Grignard reagent is probably the most important controlling factor.

Further work is in progress on the reactions of ketones and esters with Grignard compounds.

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[1] *Nature*, **155**, 19 (1945).

Antimalarial Drugs of the Indigenous Materia Medica of China and India

MY attention has been directed to a note on "A New Antimalarial Drug" by I. M. Tonkin and T. S. Work[1]. As a number of workers in China and India are still engaged in the elaboration of newer antimalarials from the rich lore of the indigenous materia medica, the following additional information on *Fraxinus malacophylla* (one of the two remedies referred to by Tonkin and Work) and others of the same species will be of interest.

I also received samples of the active ingredients from *Fraxinus malacophylla*, known in Chinese as 'Fu-Nieh-Ching', through the courtesy of Dr. J. Needham of the British Scientific Office in Chungking via Dr. J. B. Grant, formerly director of the All India Institute of Hygiene, Calcutta. The material was received in three forms : (1) antimalarial pure compound '*A*' in powder ; (ii) pale green, odourless and practically tasteless tablets of 0·013 gm., presumably made from the dried extract of the bark ; and (iii) compound '*B*'—a by-product of the bark extract. The tablets were stated to have been prepared by the Ordnance Administration Centre Research Station at Luhsien, China. All the three compounds were tested for their antimalarial efficacy on simian and human malaria, though emphasis was laid on the 'tablets', which were received in adequate quantities.

Chemical investigation showed absence of any alkaloids in *F. malacophylla*, a finding contrary to Lin *et al.*[2] but confirming the report of Tonkin and Work (*loc. cit.*). Presence of a glycoside, essential oils, etc., was proved, but no effort was made to proceed further with their systematic chemical analysis. Pharmacologically, the oral toxicity was found to be low and administration even to children could be easily recommended.

In simian malaria (*P. knowlesi* infection), the tablets or the compound '*A*' produced no effect on the course of infection. This is different from the observation recorded by Tonkin and Work of "considerable activity against *P. gallinaceum* in chicks".

In human malaria, both malignant tertian and benign tertian, fraxine tablets in dosage varying from three tablets a day to sixteen tablets a day for five days were administered in slide-positive cases hospitalized in the Carmichael Hospital for Tropical Diseases, Calcutta, under Prof. J. C. Gupta. Of five patients treated for 5–7 days (in two instances), only one remained fairly well, though his smear remained positive. He had a relapse within ten days and passed through a typical attack of ague relieved with quinine injections. The other cases gradually passed into a stage when humanitarian considerations demanded urgent treatment with quinine. A peculiar observation was made in two cases, where there was a distinct tendency to a fall in temperature suggesting a 'febrifugal effect' of the drug. In benign tertian cases, four of which were followed up, fraxine tablets did not bring about any alteration in the clinical course of the disease in two; whereas in the other two, a temporary febrifugal effect associated with disappearance of the parasites was recorded. Both the cases relapsed and had to be treated with intramuscular quinine injections.

Our conclusions with fraxine tablets are, therefore, in essential agreement with the report of Tonkin and Work ; but what we could not account for was the tendency of the drug to produce a febrifugal effect, which in a few cases was actually interpreted at the beginning as a definite antimalarial effect. There was a temporary disappearance of the malaria parasites, but this bears no resemblance to what is produced as a result of quinine administration.

I have examined two other Indian drugs of the indigenous materia medica, namely, *Alstonia scholaris*[3] and *Cæsalpinia bonducella*[4]. The former contains at least one and possibly four alkaloids, but is definitely not anti-plasmodial. The latter contains a glycoside which is also not anti-plasmodial in fowls. In both these, however, the same phenomenon of a febrifugal action was noticed, the degree of which was too pronounced in the case of *A. scholaris* to be ignored. Indian counterparts of *F. malacophylla* (*F. excelsior*, *F. micrantha* and *F. xanthoyloides*) were also examined without any success.

It appears that both in India and China indigenous vegetable drugs have earned reputation as 'malaria cures' primarily from their slight 'febrifugal' properties. Apart from cinchona derivatives, there is no other plant product known to me which can bring about an anti-plasmodial effect both in experimental and human malaria.

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[1] Tonkin and Work, *Nature*, **156**, 630 (1945).
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"Re-dedication of Science in Germany"

IN his interesting and noteworthy article "Re-dedication of Science in Germany" in *Nature* of July 13, p. 66, Prof. Polanyi refers to the Kaiser Wilhelm Institut für Physikalische Chemie in Berlin-Dahlem, and to its former director, Prof. Fritz Haber, and to the celebration in his memory on January 29, 1935.

Certain details concerning this impressive ceremony, illuminating the scientific life in Germany under the Nazis, might be perhaps of general interest and might demonstrate that even in 1935, two years after Hitler came to power, there were in Germany men of integrity. I would like to mention that Prof. Max Planck had arranged this ceremony in spite of the greatest difficulties, and in face of the strongest opposition from the Nazi Government, and it was only due to his reputation in the international scientific world that this gathering could be held. These unbelievable conditions are further illustrated by the fact that Prof. K. F. Bonhöffer, as a member of a German university, that is, as a State official in Germany, was forbidden to attend this celebration, and therefore could not deliver his lecture in honour of Haber. It might be of interest to add that Prof. Hahn read Bonhöffer's lecture in his place. At the last moment it became doubtful whether I should be allowed to attend, owing to the following circumstances. As an industrial chemist, I was a member of the Verein deutscher Chemiker. This society was already under Nazi influence, and the members received a strongly worded circular to the effect that they were not allowed to be present at this celebration. Although I was determined to ignore this order, some of my colleagues in the I.G. Farbenindustrie were in doubt as to what course they should adopt, and asked my advice. Acting against this order might have endangered their career, so I asked Prof. Bosch, chairman of the I.G. Farbenindustrie, who together with Haber developed the process for synthetic ammonia, for his advice. He answered that it was the duty of all chemists of the company who were invited to attend this anniversary. Unfortunately, Prof. Bosch died too early to continue his struggle against the Nazi regime.

This gathering of Haber's friends and admirers was, as Polanyi says, really a noteworthy manifestation of independence in German scientific circles.

One act was significant of the Nazis and of Goebbel's Ministry of Propaganda. Placards fixed on the exit doors of the lecture-room ordered the reporters of the newspapers to gather in a special room. Here they were told that no report whatever concerning Haber's anniversary and the celebration was to be published in German papers. So it came about that the German people did not know that there was a Haber celebration in Germany in 1935 under the chairmanship of Planck, and that at this gathering the representatives of many countries, ambassadors and men of science were present. There were, and there still are German men of science of integrity who, if allowed to start research work, could continue their struggle against Nazi ideas with renewed energy, and could try to build up a new German scientific life in a democratic way.

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[The anniversary celebrations to which Dr. Mendelssohn-Bartholdy refers were described and commented on at the time in *Nature* of February 2, p. 176, and February 9, p. 216 (1935).—EDITORS.]

RESEARCH ITEMS

Palæolithic Child from the Teshik-Tash Cave

FRANZ WEIDENREICH has published an important note on the alleged Mousterian skull from the Teshik-Tash Cave in southern Uzbekistan (Central Asia) (*Amer. J. Phys. Anthrop.*, N.S., 3, No. 2; 1945). He does not consider that the skull is that of a Neanderthalian of the Mousterian European type. He is not prepared to discuss the geological reasons which have been adduced to suggest this early date, but he does point out that the faunal and cultural indications would not be incompatible with a late Upper Palæolithic one. Weidenreich also mentions certain other Russian finds, more particularly the Podkumok skull. Here again the object does not appear to be of normal Neanderthal facies. Actually, Weidenreich suggests that both the Uzbekistan, the Mount Carmel, and perhaps the Podkumok human remains, are intermediate links between Neanderthal man and *Homo sapiens*; and, as these come from western and central Asia, further important discoveries may be looked for in these regions.

Absorption of Light by Blood Plasma

UNDER the title "La Absorción Luminosa Del Plasma Sanguineo y La Estabilidad De La Misma Frente A Diversos Agentes", Antonio E. Rodriguez and Jose A. Balseiro have described the results of their investigations of the absorption of light from the red to the ultra-violet by solutions of blood plasma taken from human beings and rabbits (*Pub. Fac. Cien. Fisicomat.*, 3, No. 1; Univ. Nac. De La Plata). A description of the apparatus employed is given and several spectrograms and diagrams show the results obtained. In the visible end of the spectrum there was nothing to indicate that absorption bands could be attributed to absorption by the plasma solutions. In the ultra-violet region it was found that there was a definite absorption band extending from 2570 A. to 2920 A., and this band is shown in solutions of various concentrations. A photomicrograph of one of these reveals that the band is relatively simple. Heating the plasma solutions to 100° C. had no effect on the absorption. The globules were separated by ammonium sulphate with an equal amount of a solution of the plasma, the concentration of the latter being equal to that which exists in the blood, and it was found that the absorption observed was due to the globules. A photograph of the bands from a specimen of plasma and another from the bands of the globules are practically identical, and a photomicrograph shows the similarity of both bands.

Club Root of Brassicas

G. Samuel and S. G. Garrett (*Ann. Appl. Biol.*, 32, 96; 1945) have described a new technique for the investigation of early stages in the attack of cabbage plants by the fungus *Plasmodiophora Brassicæ*. Seedlings are grown for short periods in small quantities of soil in glass tumblers. Roots of young seedlings thus grown are placed in acetocarmine, which stains the zoosporangia of the parasite in infected root hairs. Infection can only take place during the very short period prior to vacuolation when the root hairs are full of protoplasm, and the authors figure the rarely seen stages of zoospore formation and discharge. Heavy applications of lime sometimes fail to control club root, and the explanation probably lies in the initial concentration of spores present in the soil. Tumbler experiments show that seedlings remain clean at pH 7·7 with 100,000 spores per ml., but there is marked infection with 10,000,000 spores per ml. At this high spore concentration infection is a little more severe than at pH 6·2 with 100,000 spores per ml. A comparison of the action of the hydroxides, carbonates and chlorides of the alkali metals shows that a reduction in infection on application of these compounds was due to their effect on the pH of the soil, the chlorides having little effect. Quite apart from the action of hydrogen ions, there is a progressive decrease in disease-rating with increase in concentration of the nutrient fluid. High soil moisture favours the disease, but the lower level at which infection takes place is partly controlled by soil texture. These experiments relate to the initial root hair infection, and do not deal with the subsequent zoospore and zygote infections, or to the development of plasmodia and 'clubs'.

Abrasives and the Transmission of Plant Viruses

THE degree of dilution which a virus extract can sustain without loss of infectivity has been regarded as sufficiently standard for diagnostic significance. H. Kalmus and B. Kassanis have recently shown, however (*Ann. App. Biol.*, 32, No. 3, 230; Aug. 1945), that the infective dilution can be increased up to one hundred times by the use of certain abrasives in the practice of inoculation. Celite (diatomaceous silica), animal charcoal and 400-mesh carborundum were all suitable, though some preparations of carborundum and charcoal reduced infectivity. The abrasive can be dusted on the leaf, which is then rubbed by the finger wet with the inoculum, or it can be rubbed on the leaf without inoculum, which is then sprayed upon the surface. Leaves regain their normal resistance to sprayed infection, however, three hours after rubbing. It may be possible, by use of the abrasive method, to standardize the dilution end-point of mechanically transmitted viruses and thus use it for diagnostic purposes with greater certainty.

Nitrogenous Manuring and Eyespot of Wheat

THE effect of eyespot (*Cercosporella herpotrichoides*) on wheat receiving dressings of ammonium sulphate has been studied by M. D. Glynne, W. M. Dion and J. W. Weil (*Ann. App. Biol.*, 32, 297; 1945). Two divergent tendencies were observed which explain the variable conclusions of previous workers. High nitrogen dressings promote luxuriant growth, lead to higher humidities within the crops, and consequently to higher rates of culm infection. On the other hand, tiller production is encouraged, which tends to offset any loss in yield. The balance of these two factors is no doubt much influenced by soil, by climate, and by the time of application of nitrogen; but in general, applications of ammonium sulphate are beneficial to affected crops, provided the dressings are not so heavy as to cause lodging.

Petrology of Heard Island

DURING the British–Australian–New Zealand Antarctic Research Expedition of 1929–31, under the leadership of Sir Douglas Mawson, thirty-five rock specimens were collected from Heard Island. G. W. Tyrrell's account of these has been published (*Rep. B.A.N.Z. Antarctic Research Exped.*, A, 2, Part 3; 1937), copies of which have just become available.

The petrology follows the general plan of oceanic volcanic islands. The commonest rock-type is trachybasalt, accompanied by variations in the ultrabasic direction through olivine-rich trachybasalt and ankaramite to limburgite, and in the other direction through trachyandesite to trachyte and phonolitic trachyte. Five new chemical analyses are provided, bringing the total for the island up to ten. These show that the alkali-lime index for the rock-series is 51, indicating that the series lies on the boundary between the alkalic and alkali-calcic series as defined by Peacock. For the volcanic series of Jan Mayen the value of this index is 51·2. The author directs attention to the remarkable homology in geological structure, regional setting and petrological composition which obtains between Kerguelen and Heard Island on one hand and Iceland and Jan Mayen on the other. Like Iceland, Kerguelen is largely built of basaltic lavas with subordinate lavas resting upon a basement of older basalts. Like Jan Mayen, Heard Island consists of members of the trachybasaltic suite; both series give almost identical variation diagrams. Iceland and Jan Mayen rise from the submarine platform connecting Greenland with the Hebrides, while Kerguelen and Heard Island rise from a submarine plateau that probably connects up with the Antarctic continent. A modern account of the Kerguelen lavas with ten new analyses is given by A. B. Edwards (*Rep. B.A.N.Z. Antarctic Research Exped.*, A, 2, Part 5).

Uplift of the Pir Panjal Range, Kashmir

A fossil leaf of *Woodfordia fruticosa*, a species of tropical shrub, collected from the Lower Pleistocene deposits of the Kashmir slopes of the Pir Panjal Range at 6,000 feet above sea-level, has been described by G. S. Puri (*J. Indian Bot. Soc.*, 22, 125; 1943). At the present time the species is widespread in the tropical parts of Africa and Asia, but is absent from the Kashmir valley and the northern slopes of the Pir Panjal Range, though it is fairly common on the Punjab side of the Range, where the climate is warmer. The author concludes that the Range has been uplifted by at least a few thousand feet since the early Pleistocene. As a result of this uplift the monsoons are unable to reach the Kashmir Valley, from the flora of which, in consequence, tropical elements have been eliminated, while temperate species have found the changed climate congenial. At the joint meeting of the Indian and National Academies of Science in 1943, the author added support to this view by describing fossil leaf fragments of *Litsea lanuginosa* from the same deposits at a height of 10,600 ft. This species now flourishes in the Sub-Himalayas, between 2,000 ft. and 4,000 ft., east of the Sutlej River, but is unrepresented in the Kashmir Valley and on the northern slopes of the Pir Panjal. There is a single record of its occurrence on the south-west slopes of the Range at 4,000 ft.

Magnetic Susceptibilities of Certain Organic Compounds and Glasses

In the course of an investigation of the change of magnetic susceptibility of certain organic compounds in passing from the solid to the liquid state, M. Mikhail, of the Physics Department, Fouad I University, Cairo, has made a study of the residual magnetism and magnetic time-lag of a Weiss electromagnet. (*Proc. Math. Phys. Soc. Egypt*, 2, No. 2, 55; 1942.) The electromagnet was specially constructed in the laboratory workshop, and the results of the experiments performed on this magnet show that for the same magnetizing current the rate of decay of the magnetic field is greater than the rate of growth but smaller than the rate of reversal. The time taken by the field to become practically constant and for the residual magnetism to reach its limiting value is not more than a few seconds. In a later paper (*Proc. Math. Phys. Soc. Egypt*, 2, No. 3, 7; 1943) a description is given of measurements by the Gouy method of the magnetic susceptibilities of soda, 'Monax', 'Pyrex' and 'Jena' glasses. Both rods and tubes were used. The object was to find which kind of glass had the least susceptibility. The results show that glasses rich in silicon dioxide are distinctly diamagnetic, that 'Monax' has the least susceptibility and that its feeble paramagnetism can be completely destroyed by raising the temperature to about 40° C.

Precision A.C./D.C. Comparator for Power and Voltage Measurements

In recent years there has been a marked increase in the demand for more accurate commercial A.C. power-measuring instruments. The demand is due largely to changing industrial conditions brought about by legislation, although it existed already for the manufacturer whose A.C. standardizing apparatus was only comparable in sensitivity and accuracy with that of the commercial apparatus he produced. A paper by G. F. Shotter and H. D. Hawkes read in London before the Institution of Electrical Engineers gives a brief review of the sources of error common to dynamometer wattmeters and emphasizes some of the inherent errors which have been less publicized. A new instrument for the measurement of A.C. power and voltage by direct comparison with a standard D.C. potentiometer is described, the principle of operation being a null method based on the balancing of two torques. A summary is given showing the errors inherent in the new instrument and those which have been eliminated by the method of measurement. The stability of accuracy of the new instrument is maintained by self-standardization, and means of checking the accuracy of the associated apparatus are made available.

Drinking Water from Sea Water

The problem of providing drinking water for airmen and sailors in collapsible dinghies and lifeboats received attention during the War, and one solution was the use of briquettes of a material containing silver zeolite. Two papers describing work carried out in parallel (H. Ingleson, *J. Soc. Chem. Ind.*, 64, 305; 1945. E. I. Akeroyd, E. L. Holmes and A. Klein, *ibid.*, 65, 28; 1946) give particulars of the research and the results. The material consisted of briquettes of reagent containing silver zeolite, barium hydroxide octohydrate, fuller's earth and graphite. It was put into a moulded plastic cylinder with screwed ends, with a changeable filter pad at one end through which the treated water was sucked through a teat. A measured volume of sea water was put into the cylinder with one chemical charge, and after one hour the filtered drinking water was sucked out, an air vent being provided at the other end of the cylinder. The barium was for removing sulphate from the water. The space occupied in a pack by this outfit was one sixth of that taken up by a tin containing the same amount of fresh water as could be provided by the treatment. Full details are given in the papers.

BIOLOGY OF *PATELLA* IN GREAT BRITAIN

By Prof. J. H. ORTON
University of Liverpool

THE recognition of at least three good species of *Patella* in the south of England by Fischer-Piette in 1935[1], with confirmation of two of these in a searching ecological study by Eslick 1940[2] at Port St. Mary, Isle of Man, renders all special observations on *Patella vulgata* prior to Fischer-Piette's work subject to revision.

This note especially reviews new observations on those sex-phenomena in *Patella* noted by Orton in 1928[3].

In occasional visits to Trevone, North Cornwall, during the War it was found that the three species, *vulgata*, *depressa* (= *athletica*) and *intermedia* (their complicated synonymy is given by Eslick[2]), are common in this locality, and that although their major distributions are as described by Fischer-Piette[1], in certain suitable spots at about low-water neaps all three species can be taken in quantity within an area of a few square metres. It was found that while the breeding periods of *depressa* and *intermedia* are somewhat similar, these differ from that of *vulgata*, thus giving the first physiological specific difference. Nevertheless there is an overlap in breeding whence it is possible to carry out cross-fertilizations. Artificial cross-fertilizations of all three species made on the beach with untreated sea-water in jam jars gave high percentages of larvæ, but as the sea-water may have contained naturally spawned sperm of all species, the apparent success can only be regarded as an encouragement to repeat the crosses with sterilized water. A study of the interrelationship of the three species by hybridization may produce interesting results on sex-phenomena as well as general biology.

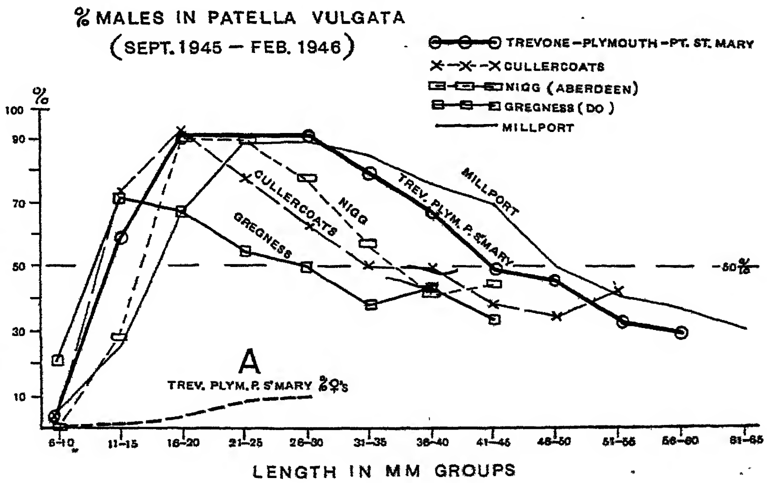
Familiarity with the three species at Trevone made it easy to distinguish the *vulgata* facies from the two other species. In distribution *vulgata* alone is found on bare rock from about half-way between L.W. neaps and ½-tide to H.W. neaps. *P. depressa* and *P. intermedia* are low-water forms, but may occur in such pools as are lined with *Lithothamnion* up to H.W. neaps (Orton)[4]. These distributions have been found to be general in all habitats examined, except that *P. intermedia* has as yet been found only in the south and south-west of England. For this reason the samples of *P. vulgata* examined by Orton[5] for shell-shape must all have been *vulgata* except possibly for occasional specimens of *intermedia* among the low-water samples. Thus apart from the low-water samples, that work can be referred definitely to *P. vulgata* as this species is at present defined: re-examination of low-water samples is necessary to exclude the possibility of contamination with *P. intermedia*.

In a revision of sex-phenomena in *P. vulgata* all radulæ have not yet been examined, but the strict correlation of radular tooth-type found by Eslick[2] with non-opaque-white pallial tentacles and a defined variety of colour in the foot-sole permits these characters along with habitat to be used as a criterion of the *P. vulgata* facies. The foot-sole of *P. vulgata* occasionally approaches in colour to the orange of *depressa* on one hand and the blue-black of *intermedia* on the other, but it is not unreasonable at present to regard these rare occurrences as more likely to be extreme phenotypes rather than genotypes. Nevertheless the degree of variability demonstrated in the genus *Patella* by Fischer-Piette[1] demands caution in dealing with all apparent *vulgata* as one species, and especially on the fringes of the geographical distribution.

With these reservations samples of *P. vulgata*, mostly from the mid-tide barnacle zone, were investigated from six localities ranging from Trevone in Cornwall to Aberdeen and examined for sex-proportions. The results are shown in the accompanying figure. The lengths of shells as tentative criteria of age and size are shown in 5 mm. length-groups ranging from 6 to 65 mm. Each 5-mm. group in each habitat comprises mostly about 100 individuals, with an overall average of 117 per group, and a normal size distribution has been assumed in each group. The sum of individuals for all localities is 8,692 (5,143 male, 1,128 immature). The results for Trevone, Plymouth and Port St. Mary were so concordant that they are here shown in one graph for convenience. The mean group percentage of small females is also given for these combined areas at *A* in the figure.

Except for the Gregness (Aberdeen) locality all graphs show a peak of 90 per cent males at a size of 16–25 mm. The peak is of short duration for Cullercoats but is maintained over a considerable range of size in other localities (excepting Gregness). The percentage of males gradually diminishes towards the maximum size to about 30; it was as low as 23 per cent at Plymouth.

These results are more convincing than those obtained formerly[3], and while providing virtual proof of sex-change from male to female in a section of the male population, point also to the probable occurrence of two types of males in *P. vulgata*. Obvious hermaphroditic forms are rare, due to the apparent exact somatic similarity of males and females and the fact that a long non-breeding period follows a normal complete evacuation of the gonad after spawning in the male. Direct evidence of



successive sex-phases may be obtained by experiment. The results from Gregness (Aberdeen) suggest a difference in type which may be either genotypic or due to environmental conditions markedly different from those on the adjacent ground at Nigg and elsewhere in Great Britain. Although further investigations are being made and may produce more information, it may be noted that as in *Crepidula fornicata*[6], and the oyster[7], there is a possibility that under certain conditions the normal young male phase may be evanescent or even elided, but if so the phase should be demonstrable by experiment.

P. depressa has been found in all the localities mentioned, except Millport (though Mrs. McEwen has kindly sent me this or a related form from the Isle of Eigg), collected from pools or in low water samples. This species has not yet been thoroughly examined, but shows indications of exhibiting the same sex-phenomena as *P. vulgata*. The importance of the biology of the genus *Patella* in the study of evolution recognized by the earlier workers Robson[8] and Orton[9] has been greatly enhanced by Fischer-Piette's work, as recognized by Huxley[10]. A team of workers is co-operating on different aspects of the work, namely, rate of growth, parasitization-rates and mortality, hybridization, sex proportions, environmental effects and general behaviour, all of which are bound up with the subject-matter of this necessarily restricted notice; and full details will be published later. Similar work in the more northerly and southerly latitudes of the distribution of the genus is needed and may produce results of great interest.

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[2] Eslick, E., *Proc. Linn. Soc.*, **152**, 45 (1940).
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CELL WALL DEFORMATIONS IN WOOD FIBRES

By Dr. H. E. DADSWELL and A. B. WARDROP

Division of Forest Products, Council for Scientific and Industrial Research, Melbourne

RECENTLY[1] reference has been made in *Nature* to work carried out by the Royal Aircraft Establishment, Farnborough, on the microscopic examination of the effect of mechanical strain in timber. During the war years similar work was carried out in the laboratory of the Australian Council for Scientific and Industrial Research (Division of Forest Products) and special attention was paid to certain naturally occurring cell-wall deformations. These deformations, called slip planes and minute compression failures, are described fully in the literature[2] and have always been of considerable interest in this laboratory because of the relationship observed between the occurrence of minute compression failures and lowered impact strength, particularly in the so-called 'brittle heart' of Australian timbers[3]. Deformations of similar appearance to both slip planes and minute compression failures have been recorded for certain textile fibres under the name 'dislocation marks'[4].

All these features can be detected microscopically by examination in polarized light between crossed nicols—they appear bright when the fibre is in the extinction position (see Figs. 1*a* and *b*)—and by the use of stains, for example, iodine and specific lignin stains. Furthermore, they are known to be susceptible to acid attack resulting in the formation of 'broken fibres'[3]. Treatment with dilute alkalis does not have this latter effect. Ambronn[5], on the basis of optical studies, deduced that the dislocation marks of textile fibres were in the form of a fold or crinkle in the cell wall. This explanation has been applied to the optical behaviour of slip planes and minute compression failures, and it has been concluded that the slip plane is a single fold in the cell wall and the minute compression failure a double fold (Fig. 2).

a

b

c *d*

Fig. 1

a, *Eucalyptus regnans* F. v. M. A 5-micron radial longitudinal section viewed between crossed nicols with the fibres in the extinction position. A minute compression failure is seen in the centre of the photograph with some adjacent slip planes. (× 780.) *b*, As in (*a*), but the fibres in the brightness position. (× 780.) *c*, A bundle of jute fibres viewed between crossed nicols, showing dislocation marks. (× 340.) *d*, *Eucalyptus regnans* F. v. M. Holocellulose fibre containing a minute compression failure—acetylated 4 hours and then treated with aniline—viewed between crossed nicols with the fibre in the brightness position. (× 340.)

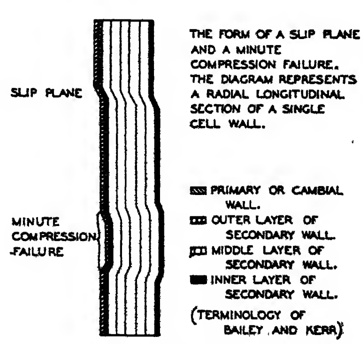

Fig. 2

Thus, if the fibres were in the extinction position the micellar arrangement in the region of both slip planes and minute compression failures would be oriented in a position of relative brightness and vice versa (see Figs. 1*a* and *b*). The angle of the micellar arrangement to the longitudinal fibre axis has been determined in studies of the dichroism of fibre sections stained with Congo Red.

The optical properties of these features have been correlated with their staining reactions and susceptibility to acid attack. Searle[6] attributed the staining reactions and acid susceptibility of dislocation marks to the local depolymerization of the cell-wall carbohydrates. A similar explanation was previously considered in this laboratory in regard to slip planes and minute compression failures. The preferential staining of the two latter features by lignin stains was attributed by Robinson[2] to the rupture of cellulose-lignin interfaces in the cell wall. This has been confirmed by the use of the specific staining method for the detection of lignin developed by Coppick and Fowler[7]. However, iodine stains (for example, Herzberg's) are effective in revealing slip planes and minute compression failures both in untreated and delignified fibres and thin wood sections. Staining with iodine in the presence of potassium iodide is primarily an adsorption effect[8]. In view of the above it has been concluded that the preferential staining effect on slip planes and minute compression failures is primarily physical, resulting from an increased adsorption of iodine. This would suggest increased micellar surfaces in these regions.

The possible influence of cell-wall composition on chemical susceptibility has been investigated by determining the rate of formation of broken fibres on acid hydrolysis. For this purpose holocellulose fibres were prepared from thin wood sections of *Eucalyptus regnans* F.v.M. in which numerous minute compression failures had been observed. These fibres were extracted with various concentrations of dilute alkali so that the material used for acid hydrolysis differed in composition from holocellulose to Cross and Bevan cellulose. Within the limits of the experiment, no increase was observed in the rate of formation of broken fibres. The chemical susceptibility of slip planes, minute compression failures and dislocation marks has been further demonstrated by the acetylation of fibres containing these features and the subsequent treatment of the acetylated fibres with cellulose acetate solvents which were found to dissolve the fibre in the region of the failures because of the preferential acetylation (Fig. 1*d*). From these observations and the work on staining referred to earlier it has been concluded that cell-wall composition is not the dominant factor governing the staining reactions and chemical susceptibility of these features.

It is suggested that the cell-wall deformations revealed by optical studies are accompanied by increased micellar surface (evidence from staining reaction) and increased inter-micellar spaces. It is of interest to note that Sisson has reported[9] that the kinetics of cellulose derivative formation is determined rather by the velocity of diffusion of the reagent than by the speed of the chemical reaction, that is, initially the rate is determined by the nature of the inter-micellar spaces through which the reagent becomes accessible to the micellar surfaces. Thus in the acetylation experiments referred to, the susceptibility of the deformations in the cell wall very probably results from an initial rapid diffusion of the reagent through the fibre wall because of the altered micellar arrangement and the increased inter-micellar spaces. In addition, the reaction would proceed more rapidly because of increased micellar surface. Dilute acids are also known to react on the micellar surface[10], and the formation of broken fibres using these reagents can thus be explained. Broken fibres are not formed when dilute alkalis are used because such reagents would be of insufficient concentration to attack the cell-wall carbohydrates or to produce a degree of hydrolysis comparable with that of the acid.

It has been concluded that the slip planes and minute compression failures of wood are morphologically similar to the dislocation marks of textile fibres, and that the conception presented in the diagram is consistent with the optical and mechanical behaviour of these cell-wall features as well as with their staining and known chemical susceptibility. A more detailed account of the investigations reported here, together with possible explanations for the formation of slip planes and minute compression failures in timber, will be published elsewhere.

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STRUCTURE OF THE EXTRA-GALACTIC NEBULÆ

UNDER the title "On the Structure of Disk-shaped Extragalactic Nebulæ", F. Hoyle has published four papers (*Mon. Not. Roy. Ast. Soc.*, **105**, 5, 287; and 6, 363; 1945) in which the investigation of the structure of the extragalactic nebulæ is based on the view that the combined mass of the stars in a nebula is only a small fraction of the total mass of the diffuse material existing between the stars. This is not a mere *ad hoc* assumption, nor is it an entirely new view; it has been advocated by others, but Hoyle is the first to show the full implications of the hypothesis.

The properties of the interstellar material, from which the gravitational field arises, are considered on the assumption that it is distributed with symmetry about the axis of rotation of the nebula, the material being composed mostly of hydrogen. In addition to hydrogen, it is considered that there is a small proportion of heavier elements present, partly in gaseous form and partly as interstellar dust, the latter being very important on account of its ability to radiate energy. In nebulæ, except those of very small mass—of the order about 10^8 times that of the sun—this interstellar material forms a flat rotating disk, the plane of the disk being perpendicular to the axis of rotation. If the period of rotation of the nebula increases outwards, as in the case of such nebulæ as *M* 33, *M* 31, and the Galaxy, an axially symmetrical distribution of material is stable. Centrifugal force prevents radial contraction of the disk, and gas-pressure gradients prevent contraction in a plane perpendicular to the plane of the disk.

On the view that hydrogen is the chief constituent of the interstellar material, it is shown that the temperature must be less than 20,000° : if it exceeded this, the hydrogen would radiate energy at a rate which exceeds the luminosity of the nebula, which is of the order − 17. Knowing the mass per unit area of the disk of the nebula, that is, the mass contained in an infinite cylinder of unit cross-section with generators perpendicular to the plane of the disk, and also the temperature, it is possible to calculate the thickness of the disk. This is found to be small in comparison with the observed radii of the nebulæ, and in the case of such nebulæ as M 33 and M 31 the ratio is about 10^{-2}.

Certain astronomical problems directly connected with the condensation of stars are discussed in the second paper under the heading "On the Condensation of Stars, The Luminosity Function, and the Distribution of Bright Stars". A statistical study of stars in our Galaxy shows that if $N(M)dM$ represents the number of stars with masses lying between M and $M+dM$, then $N(M)$ decreases rapidly with increasing M. This is true down to values of M of about one fifth that of the sun ; adequate statistical evidence is difficult to obtain for stars of smaller masses owing to their faintness. If we adopt the short time-scale of about 10^{10} years for the age of the universe, a star of mass less than that of the sun could not have exhausted by nuclear transformation any large fraction of the hydrogen that it originally possessed at the time of its condensation from diffuse gaseous material, and hence the short time-scale requires the form of the function $N(M)$ to be a property of the condensation process. On the long time-scale, however, it is possible to interpret the luminosity function in terms of stellar evolution, and in this case it might be argued that stars of half the sun's mass are more numerous than stars of the sun's mass because more of the latter type have burnt themselves out. As this explanation does not seem possible, it must be assumed that the condensation process involves certain features which prevent the formation of stars of large masses.

It is shown that if the angular momentum of a condensation is calculated from the average observed value of dV/dr, the stellar rotational velocities are of the order 10^9 cm./sec. ; these velocities are so high that rotationally stable stars cannot be formed unless one of two conditions is fulfilled : (1) the star condenses at some special distance r_0, where $dV/dr = 0$; (2) some further process intervenes to prevent the occurrence of rotational instability.

The only process that can account for the rotationally stable stars is the accretion of diffuse material before rotational instability commences. But the question arises : "Can accretion be sufficiently rapid to slow down the rotation of the star so as to prevent rotational instability ?" To answer this question we must possess some knowledge of the time required for the contraction of the condensation to the stellar state, and it is found that for a condensation of fixed mass M the time is approximately proportional to M^{-4}. For a condensation of mass twice that of the sun the time is of the order 10^7 years, but for a star of mass one fifth that of the sun it is of the order 10^{11} years. It appears, therefore, that there is ample time for accretion to play an important part in slowing down the rotation of small stars ; but in the case of the more massive stars—those exceeding twice the mass of the sun—the time is much too short for accretion to have any important effect. For this reason it is suggested that the only condensations which can form stable stars are those of small mass. The rotationally unstable stars of large mass throw off to infinity a large proportion of their mass, the nucleus which remains being of small mass and rotationally stable. The third paper, "On the Formation of Multiple Systems", confirms the view that stable stars are formed only from condensations of small mass.

Bright stars of large mass must belong to one of two groups : (1) those which condense at r_0, where $dV/dr = 0$; (2) those that are of small mass at the time of condensation, but increase in mass by the rapid accretion of diffuse material. The first type forms a concentration of bright stars in a ring of radius r_0, and this should occur in the outer regions of the nebula, because in those regions $dV/dr = 0$. Observational evidence confirms the existence of such a bright ring.

The second type has special interest in relation to the problem of spiral arms, a subject dealt with in the fourth paper of the series. In Section 1 of this paper it is shown that under certain conditions stars of a large rate of accretion are confined at a particular time to two opposite diameters of the nebula, and the subsequent distribution of such stars depends on $P(r)$, the period of rotation. If this increases outwards, the stars are distributed along two spiral arms which gradually wind themselves up. This implies that the arms trail behind the nucleus in all spiral nebulæ, which is different from the conclusion reached on the theory of rotational instability ; in the latter case the arms must be advanced.

Hoyle has supported his theory by a most careful consideration of all the conditions, and if it is accepted, drastic alterations in the subject of galactic dynamics and nebular structure must be expected. It remains to be seen whether observational evidence will confirm the theory advocated.

TRIFOLIUM SUBTERRANEUM LINN. IN AUSTRALIA : AN AUTECOLOGICAL STUDY

SINCE Turesson demonstrated the existence of ecotypes arising from the selective action of environmental factors upon the genotype, well-conducted investigations have been made into the biotypes of many wild plants. With notable exceptions, there has not been the same activity in relation to naturally occurring plants of economic value which have been brought into cultivation and, although the agricultural possibilities of varieties are assessed, their origins are not examined so often. Yvonne Aitken and F. R. Drake have examined the subterranean clover in Australia (*Proc. Roy. Soc. Victoria*, 53 (N.S.), 342 ; 1941), and the organisation of their investigation is worthy of notice.

First the type variety in Australia, "Mt. Barker", is described and genotypical variations listed from material collected from different parts of the country. The origin of these 'varieties' is considered next by direct comparison of the Australian material with European samples and, less satisfactorily, with European floras. A similar range is demonstrated in both regions, and it is considered that there is no evidence whatever of any hereditable response to the altered environment encountered by the species upon

introduction to Australia; only in the distribution of anthocyanin is any noted mutation considered to have occurred. The varietal distribution seems to be a chance one, with environment preventing the persistence of late-maturing types in short-season districts, while a heavier setting of seed favours the late types in long-season districts.

The responses of the varieties to time of sowing, day-length and relatively high temperature (which inhibits flowering and, therefore, gives a longer grazing-period) have been studied in detail. By means of trials conducted at several stations, the effect of latitude and season on time of flowering of autumn-sown plants has been investigated and, finally, observations were made upon production according to variety and environment, using both spaced plants and those grown in swards.

INDIAN RESEARCH FUND ASSOCIATION

THE technical report of the Scientific Advisory Board of the Indian Research Fund Association* for the year 1944 includes an account of researches carried out during the year together with reports of the advisory committees on cholera, malaria, nutrition, plague, and anti-smallpox vaccination in British India, with a note on the *Indian Journal of Medical Research* and *Indian Medical Research Memoirs* and a list of miscellaneous papers issued under the auspices of the Indian Research Fund Association.

The cholera treatment inquiry, under the director of the School of Tropical Medicine, Calcutta, describes the results of investigations on the treatment of cholera cases with sulphaguanidine and with sulphasuxidine. Important conclusions have been drawn from an inquiry on the statistical evaluation of anti-cholera inoculation in the Madras Presidency. Under the Malaria Research Institute of India, investigations on insecticides and on repellants and protective clothing are reported, including trials with dimethyl phthalate and with D.D.T., and a statistical inquiry into methods of forecasting epidemic malaria. Nutrition researches under Dr. W. R. Aykroyd at the Nutrition Research Laboratories, Coonoor, covered the analysis of foods; animal experiments on vitamin P and vitamin C, on experimental fluorosis, clinical and field investigations, etc., while an ascorbic acid inquiry under Dr. D. N. Ghosh at the University College of Science and Technology, Calcutta, related to the biosynthesis of ascorbic acid under the influence of narcotics. An inquiry on the formation, functions and variations of plasma proteins in health and disease, under Mr. N. C. Dappa at the Grant Medical College, Bombay, has confirmed the relations of hypoproteinæmia and œdema and of hyperproteinæmia and hyperglobulinæmia. Mr. M. N. Rudra has continued an investigation into the role of manganese in the biological synthesis of ascorbic acid at the Prince of Wales Medical College, Patna. Other nutrition inquiries have covered the factors affecting normal calcium metabolism in certain areas of the Punjab, protein metabolism by human feeding experiments, the deterioration of vitamin A in liver oils, concentrates and other preparations and the relation between the vitamin B complex and tumour growths, as well as tests on the biological value of soya bean protein, growth tests with soya bean and human experiments with soya bean. The estimation of vitamin A activity in plant foods has been investigated at the Punjab University Institute of Chemistry, Lahore, the role of nutritional factors in hepatic cirrhosis at the Haffkine Institute, Bombay, and the chemical nature and nutritional availability of food iron, under Dr. D. N. Ghosh, at the University College of Science and Technology, Calcutta.

Leprosy investigations at the School of Tropical Medicine, Calcutta, and the Lady Wellington Leprosy Sanatorium, Chingleput, Madras, are also reported, as well as plague researches under the director of the Haffkine Institute, Bombay, and a plague inquiry in the Salem district under the Director of Public Health, Madras. Pharmacological investigations have included an indigenous drugs inquiry under Dr. J. C. Gupta at the School of Tropical Medicine, Calcutta, and under Sir Ran Nath Chopra at the Drug Research Laboratories, Jammu, Kashmir, and a pharmacological inquiry on synthetic anti-malarial drugs under Dr. B. B. Dikshit at the Haffkine Institute, Bombay.

Other researches noted in the report include Dr. D. N. Ghosh's investigation into medical mycology at the School of Tropical Medicine, Calcutta, Dr. Sundar Rao's investigation on filariasis at the School of Tropical Medicine, Calcutta, and an investigation of filterable viruses at the King Institute, Guindy, Madras, and a kala-azar investigation under the director of the Pasteur Institute, Shillong. Methods for the manufacture of solid blood plasma and other related problems have been investigated under the director of the All India Institute of Hygiene and Public Health, Calcutta.

* Indian Research Fund Association. Report of the Scientific Advisory Board for the Year 1st January to 31st December, 1944. Pp. vii+188. (New Delhi: Indian Research Fund Association, 1945.) 1 rupee.

FORTHCOMING EVENTS

Wednesday, August 7—Thursday, August 8

BRITISH SOCIETY OF ANIMAL PRODUCTION.—Summer Meeting.

Wednesday, August 7

At 10.15 a.m. (at the West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2).—Discussion on "The Collection, Interpretation and Use of Milk and Butterfat Records" (to be opened by Mr. J. Edwards and Mr. A. H. Ward).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN AERODYNAMICS AND FLUID MOTION (with subsidiary subjects Mathematics and Airframe Design or Aero Engine Design), and a LECTURER IN CHEMISTRY, at the Kingston-upon-Hull Municipal Technical College—The Director of Education, Guildhall, Kingston-upon-Hull (August 10).

TEACHERS OF CHEMISTRY, MECHANICAL ENGINEERING, AND PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (August 10).

ASSISTANT PHYSICIST TO THE RADIOTHERAPY DEPARTMENT—The House Governor and Secretary, Royal South Hants and Southampton Hospital, Southampton (August 17).

RESEARCH ASSISTANT IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Leeds (August 17).

PSYCHOLOGIST (part-time)—The House Governor, St. George's Hospital, Hyde Park Corner, London, S.W.1 (August 17).

PRINCIPAL OF THE TAUNTON TECHNICAL INSTITUTE—The Chief Education Officer, County Hall, Taunton (August 19).

RESEARCH OFFICER IN MASS SPECTROSCOPY, DIVISION OF INDUSTRIAL CHEMISTRY, COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, MELBOURNE—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W.C.2 (August 24).

UNIVERSITY LECTURERS (2) and a part-time LECTURER IN MATHEMATICS—The Secretary of the Appointments Committee, Pembroke College, Cambridge (August 24).

DIRECTOR OF RESEARCH—The Medical Superintendent, Cardiff City Mental Hospital, Whitchurch, Cardiff (August 25).

PRINCIPAL, a VICE-PRINCIPAL and LECTURER IN AGRICULTURE, and a HEAD OF THE HORTICULTURE DEPARTMENT—The Principal, Cheshire School of Agriculture, Reaseheath, Nantwich (August 26).

ASSISTANT LECTURERS IN BOTANY AND ENGINEERING, and RESEARCH DEMONSTRATORS (part-time) IN PHYSICS, CHEMISTRY AND METALLURGY—The Registrar, University College, Singleton Park, Swansea (August 26).

LECTURERS (2) IN EXPERIMENTAL PHYSICS—The Registrar, The University, Manchester 13 (August 31).

CHAIR OF MATHEMATICS—The Registrar, University College, Southampton (August 31).

JUNIOR LECTURER IN PHYSICS, and an ASSISTANT TO THE PROFESSOR OF CHEMISTRY—The Registrar, Trinity College, Dublin (September 1).

ARCHÆOLOGY OFFICER IN THE MINISTRY OF AGRICULTURE AND FISHERIES ORDNANCE SURVEY DEPARTMENT—The Director of Establishment and Finance, Ordnance Survey Office, Leatherhead Road, Chessington, Surrey (September 2).

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Aberdeen (September 6).

PRINCIPAL SCIENTIFIC OFFICERS at the Chemical Defence Experimental Station, Porton, under the Ministry of Supply, for work in connexion with specialized aspects of research in pathology, pharmacology, biochemistry and animal breeding—The Civil Service Commission, 6 Burlington Gardens, London, W.1 (September 14).

LECTURER IN PHYSIOLOGY—The Registrar, University of Otago, Dunedin, New Zealand (September 16).

DIRECTOR OF RESEARCH—The Secretary, British Baking Industries Research Association, 8 Bolton Street, London, W.1 (September 30).

SENIOR LECTURER IN ORGANIC CHEMISTRY in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.569 (September 30).

CHAIR OF PSYCHOLOGY—The Registrar, The University, Liverpool (October 12).

CHAIR OF PSYCHOLOGICAL MEDICINE tenable in the Medical School, King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (December 31).

LECTURERS IN THE DEPARTMENTS OF CIVIL AND MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, APPLIED CHEMISTRY, AND PHYSICS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN CIVIL ENGINEERING—The Director of Education, The Polytechnic, Regent Street, London, W.1.

LECTURER IN BIOLOGY at the Crumlin Mining and Technical College—The Director of Education, Education Department, County Hall, Newport, Mon.

LECTURER (Graduate) to teach mainly PHYSICS up to and including B.Sc. standard, and some Mathematics, at the Norwich City College and Art School—The Director of Education, City Hall, Norwich.

LECTURER IN PHYSICS AND/OR CHEMISTRY at the Southend Municipal College—The Chief Education Officer, Education Offices, Warrior Square, Southend-on-Sea.

LECTURER (full-time) IN METALLURGY IN THE SCHOOL OF CHEMISTRY—The Principal, Leicester College of Technology and Commerce, Leicester.

ASSISTANTS (2) to carry out computing work as members of the X-Ray Crystallography Research team at Welwyn Garden City—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

PRINCIPAL RESEARCH OFFICER by the Government of Ceylon for the Department of Commerce and Industries—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.16727.

SOIL CHEMIST to the Research Division, Sudan Department of Agriculture and Forests—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Soil Chemist'.

SENIOR CHEMIST, a CHEMIST, and a MARINE BIOLOGIST, for fisheries research posts—The Director, Newfoundland Government Laboratory, St. John's, Newfoundland.

RESEARCH ASSISTANT (Honours graduate in Chemistry) in the Inoculation Department for work on Antibiotics—The Secretary, St. Mary's Hospital, Paddington, London, W.2.

EXPERIENCED LABORATORY ASSISTANTS IN CHEMISTRY AND BIOLOGY—The Senior Science Master, Malvern College, Great Malvern.

RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING—The Principal, County Technical College, Stoke Park, Guildford, Surrey.

DIRECTOR OF RESEARCH—The Secretary, Institute of Brewing, Goring Hotel, Grosvenor Gardens, London, S.W.1.

PRINCIPAL SCIENTIFIC OFFICER—The Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Society for Psychical Research: What it is, What it has accomplished, Why its Work is Important. Pp. 20. (London: Society for Psychical Research, 1945.) 3*d*. [112

An Exhibition of German Aeronautical Developments. Contributed and arranged by the Ministry of Aircraft Production at the Science Museum by kind permission of the Ministry of Education. Pp. ii+70. (London: Science Museum, 1946.) 6*d*. [122

Bleached Lac. (British Standard 1284: 1946.) Pp. 14. (London: British Standards Institution, 1946.) 2*s*. net. [142

South-Eastern Naturalist and Antiquary: being the Fiftieth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Fiftieth Annual Congress held at Harpenden, 1945. Vol. 50. Edited by Capt. T. Dannreuther. Pp. 1 + 50. (London: South-Eastern Union of Scientific Societies, 71 Rectory Place, S.E.18, 1946.) 5*s*. net. [142

Carnegie Trust for the Universities of Scotland. Forty-fourth Annual Report (for the Year 1944–45) submitted by the Executive Committee to the Trustees on 11th February 1946. Pp. iv + 62. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1946.) [142

Civil Engineering as a Career. Pp. 56. (London: Institution of Civil Engineers, 1946.) 1*s*. [182

Sheffield Metallurgical Association. Report for 1945 and List of Members. Pp. 22. (Sheffield: Sheffield Metallurgical Association, 1946.) [182

Central Statistical Office. Monthly Digest of Statistics. No. 1, January 1946. Pp. ii+95. (London: H.M. Stationery Office, 1946.) 2*s*. 6*d*. net. [182

Colonial Office. Further Education and Vocational Training. Pp. 8. (London: Colonial Office, 1946.) [252

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 16, No. 1, June 1944. Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Keuneman. Pp. iv+74. (London: H.M. Stationery Office, 1945.) 4*s*. 6*d*. net. [252

Scottish Marine Biological Association. Annual Report, 1944–45. Pp. 29. (Glasgow: Scottish Marine Biological Association, 1946.) [252

University of Leeds. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1944–45. Pp. 32. (Leeds: The University, 1945.) [252

Other Countries

U.S. Department of the Interior: Geological Survey. Professional Paper 200: Geology and Ore Deposits of the Magdalena Mining District, New Mexico. By G. F. Loughlin and A. H. Koschmann. Pp. vii + 168 + 38 plates. 2 dollars. Professional Paper 201: Geology and Ore Deposits of the Cottonwood—American Fork Area, Utah. By F. C. Calkins and B. S. Butler; with Sections on History and Production, by V. C. Heikes. Pp. x + 152 + 51 plates. 1.75 dollars. Professional Paper 203: Stratigraphy and Fauna of the Louisiana Limestone of Missouri. By James Steele Williams. Pp. iv + 134 + 9 plates. 50 cents. Professional Paper 204: Geology of the Hanover–York District, Pennsylvania. By Anna Jonas Stose and George W. Stose. Pp. vii + 84 + 18 plates. 1.75 dollars. Professional Paper 205–A: Relative Abundance of Nickel in the Earth's Crust. By Roger Clark Wells. (Shorter Contributions to General Geology, 1943.) Pp. ii + 22. 10 cents. (Washington, D.C.: Government Printing Office, 1942–1944.) [151

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 866–B: Geology of Dam Sites on the Upper Tributaries of the Columbia River in Idaho and Montana, Part 2: Hungry Horse Dam and Reservoir Site, South Fork Flathead River, Flathead County, Montana. By C. E. Erdmann; with a Section on Geophysical Investigations, by B. E. Jones. Pp. x + 37–116 + plates 8–11. 40 cents. Water-Supply Paper 888: Stream-Gaging Procedure; a Manual describing Methods and Practices of the Geological Survey. By Don M. Corbett and others. Pp. xvi + 245 + 33 plates. 65 cents. Water-Supply Paper 889–E: Chemical Character of Surface Waters of Georgia. By William L. Lamar. Pp. iv + 317–380. 15 cents. Water-Supply Paper 908: Water Levels and Artesian Pressure in Observation Wells in the United States in 1940, Part 3: North-Central States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 288. 30 cents. (Washington, D.C.: Government Printing Office, 1942–1944.) [151

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 938: Water Levels and Artesian Pressure in Observation Wells in the United States in 1941, Part 3: North-Central States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 232. n.p. Water-Supply Paper 940: Water Levels and Artesian Pressure in Observation Wells in the United States in 1941, Part 5: North-western States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iii + 172. 25 cents. Water-Supply Paper 945: Water Levels and Artesian Pressure in Observation Wells in the United States in 1942, Part 2: South-eastern States. By O. E. Meinzer, L. K. Wenzel and others. Pp. iv + 162. 25 cents. Water-Supply Paper 960: Surface Water Supply of the United States, 1942. Part 10: The Great Basin. Pp. iv + 124 + 1 plate. n.p. (Washington, D.C.: Government Printing Office, 1942–1944.) [151

Sveriges Geologiska Undersökning. Årsberättelse för år 1939. Pp. 8. 0.50 kr. Årsberättelse för år 1940. Pp. 8. 0.50 kr. Årsberättelse för år 1941. Pp. 8. 0.50 kr. Årsberättelse för år 1942. Pp. 8. 0.50 kr. Årsberättelse för år 1943. Pp. 6. 0.50 kr. Årsberättelse för år 1944. Pp. 6. 0.50 kr. (Stockholm: P. A. Norstedt and Söner, 1940–1945.) [151

Sveriges Geologiska Undersökning. Ser. Aa, No. 182: Beskrivning till kartbladet Lidköping. Av S. Johansson, N. Sundius och A. H. Westergård. Pp. 197. 4 kr. Ser. Aa, No. 183: Beskrivning till kartbladen Visby och Lummelunda. Av G. Lundquist, J. Ernhold Hede och N. Sundius. Pp. 167. 4 kr. Ser. Aa, No. 184: Beskrivning till kartbladet Hedemora. Av G. Lundquist och S. Hjelmquist. Pp. 146. 4 kr. Ser. Aa, No. 185: Beskrivning till kartbladet Horndal. Av R. Sandegren och B. Asklund. Pp. 106. 4 kr. (Stockholm: P. A. Norstedt and Söner, 1940–1943.) [151

Sveriges Geologiska Undersökning. Ser. C, No. 435: Flintrännans och Trindelrännans geologi (Öresund). Av Fritz Brotzen. Pp. 33 + 1 plate. 1 kr. Ser. C, No. 437: Nya djuphorrningar genom äldsta ordovicium och kambrium i Östergotland och Närke. Av A. H. Westergård. Pp. 72. 2 kr. Ser. C, No. 438: Geology and Ores of the Boliden Deposit, Sweden. By Olof H. Ödman. Pp. 190 + 48 plates. 8 kr. Ser. C, No. 439: Nyare undersökningar inom Remdalens malmtrakt och dess omgivningar. Av Torsten Du Rietz. Pp. 85 + 4 plates. 3 kr. Ser. C, No. 440: Jordskalv i Sverige 1936–40. Av K. E. Sahlström. Pp. 23 + 1 plate. 0.50 kr. Ser. C, No. 441: Oljeskiffrar och skifferolje-industri. Av N. Sundius. Pp. 45. 3 kr. Ser. C, No. 442: Skifferborrningarna i Yxhultstrakten i Närke 1940. Av A. H. Westergård. Pp. 20 + 3 plates. 2 kr. Ser. C, No. 443: Relations between Ore Deposition and Structure in the Skellefte District. By Sven Gavelin. Pp. 16. 0.50 kr. Ser. C, No. 444: Copper Ores of the 'Red Beds' Type from Visingsö, Sweden. By Olof H. Ödman. Pp. 26. 1 kr. Ser. C, No. 445: Grunddragen av fjällkedjerandens bergbyggnad inom Västerbottens län. Av Oskar Kulling. Pp. 320+1 plate. 6 kr. (Stockholm: P. A. Norstedt and Söner, 1940–1942.) [151

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VOCATIONAL GUIDANCE AND THE SHORTAGE OF MAN-POWER

ONE corollary of the recognized shortage of scientific and technical man-power is the necessity of ensuring that the most effective use is made of the present limited resources. That problem has engaged the attention of the Barlow Committee, and from another angle has been considered by the Hankey Committee on Higher Appointments and by the University Appointments Boards themselves, as an article by Dr. C. P. Snow in the *Political Quarterly* and a recent report from the Cambridge University Appointments Board indicate. There are in fact two distinct aspects of the problem, quite apart from the question of the content of the training given in university and technical colleges : first, the question of ensuring that while the expansion of the universities and technical colleges is proceeding to a point commensurate with the demand, all that is possible is done to ensure that no potential students of outstanding ability are lost to the nation because economic or other reasons prevent their proceeding to the university ; and secondly, that of placing them in industry and elsewhere and seeing that the most effective use is made of their services when trained.

The imperative need in the post-war world of increasing our industrial efficiency has stimulated widespread interest in Britain in technical education in the broadest sense. The concern which has been expressed at delay in reaching a decision regarding the period of call-up for service in the Armed Forces has largely been prompted by the wastage of trained man-power caused thereby. Such concern has not been entirely relieved by the latest Government announcement regarding the call-up of university students, welcome as some of the features of the new policy undoubtedly are. There is some difference of opinion as to whether in any event a period of national service should be taken before proceeding to the university or, if the period of service is no more than eighteen months, during the university course. Either proposal is likely to cause some wastage or inefficiency. But it could equally well be argued that for the scientific student, as for the engineer or the medical student, the policy most conducive to efficiency is to superimpose a shortened period of military training on the graduate at the end of his university training. Such a policy would appear to be more in accord with the increasing technical character of modern warfare and might avoid some of the uncertainty inherent in the present policy.

Meanwhile, however right it may be in present circumstances to reserve 90 per cent of the number of places in the universities to those who have served in the Forces, it is essential that such entrants should be of the requisite standard from the point of view of the university. To limit the new entries from schools to 10 per cent puts a high premium on the efficiency of our present methods of selecting the most talented

student, and also as corollary demands that we should be careful not to exclude what may be a high standard of mediocrity in favour of a lower one provided by the Forces.

These circumstances enhance the importance of our present methods of selection for entry to the university, whether by the scholarship system or in other ways. While, however, a fair amount of attention has been given to the desirability of recruitment from as wide a range as possible to ensure that ability is not lost in whatever social strata of the population it is found, little attention has been directed to this particular aspect of the problem, or the consequences which may follow if our methods of selection and training are defective. The House of Commons, for example, has debated on at least two occasions during the present session recruitment to the higher posts of the public services, dealing with it from the point of view that such posts should not be limited to one social class or those with a particular outlook. While evidence was advanced by Government spokesmen that recruits are to an increasing extent drawn from a wide range of schools and also to the disappearance of class distinctions, the fundamental issues were scarcely touched.

This problem cannot be confined to recruitment and training for higher positions or for technical and scientific posts in Government service or industry and business. It is linked up with that of the quality and content of education generally, and with methods of recruitment and training within industry and the increasing range of services for which Government is assuming responsibility. Even the highest standard of leadership cannot achieve its full results unless it has efficient workers to carry out the operations required. In a State based on social security, with its corollary of full employment, industrial efficiency not merely demands trained and intelligent workers at all levels, but also mobility and a new set of incentives in which group relations may require special study.

On such grounds as these the whole question of vocational guidance and industrial psychology demands re-examination, and Pierre Naville's "Théorie de l'Orientation Professionelle"* is a contribution which deserves attention from the industrial psychologist and also from professional men in general. M. Naville does not indeed limit himself to the professions in the narrow sense: he is concerned with the factors which determine the choice and practice of an occupation, and the distribution of youth in the different occupations in the broadest sense. He submits the whole conception and practice of vocational guidance and selection to a close and critical examination in an endeavour to arrive at the fundamental issues.

The historical survey with which M. Naville starts leads him to insist that the occupational distribution of youth is not the result of chance or the expression of different natural aptitudes but the outcome of a given social regime. Substantiation of that conclusion in itself would warrant re-examination of our premises and practice in vocational guidance in the light of the needs of a new order, in which the distribution of skills may be widely different and new skills and greater mobility may be essential. Examining next the question of the direction of labour and its implications, the criteria of occupational success, the division of labour according to aptitude and the theory of aptitude, he challenges the subjectivity of personal judgments in professional notes, and discusses alike the limitations of statistical correlation in this field, the relation of aptitude to adaptability and the inheritance of professional ability. Finally, a discussion of the biological and social aspects of adaptation leads M. Naville to examine briefly some actual problems in orientation and selection, the diagnoses of adaptability, the place of the medical examination, the use of statistics, and the correlation of educational and professional selection.

M. Naville does not regard vocational guidance, in its present state of development, as more than a social technique; but this challenging and often provocative book, in which without being obtrusive the socialist outlook is never hidden, should be a powerful stimulant to the fundamental thinking and further investigations required to transform industrial psychology into something approaching a science. The programme of reforms which M. Naville advocates in conclusion, while primarily for the reform of French practice, are designed to improve technical efficiency in this field generally, and have points which will bear consideration also in Britain. Vocational guidance should be unified at all educational levels, from the primary to the university, and a university bureau of statistics should be attached to the centres of vocational guidance (and in France to the National Institute of Professional Orientation). Both the collective and the individual aspects of selection should receive attention in the preparation of plans to meet vocational needs; and it is recommended that the responsibility for the direction of professional orientation should be entrusted to the national Minister of Education assisted by a commission on which the Minister of Labour is represented. Other recommendations cover the co-ordination of the various centres of vocational guidance, public and private, the reservation to the State of a quasi-monopoly of guidance as a control of the movement of man-power, an organic link between centres of vocational guidance, statistical services, labour exchanges and health services, and the establishment of a body of medical men specializing in vocational guidance, and recruited in the first instance from medical inspectors of factories and schools. At least two years study should be required of those desiring to practise as advisers in vocational guidance, and the National Institute of Professional Orientation should become the focus of theoretical and experimental studies carried out by the centres of professional orientation and be adequately endowed for publication purposes.

Such are the practical measures which M. Naville advocates for adoption in France as a result of a stimulating and fundamental study, and which

* Théorie de l'orientation professionnelle. Par Pierre Naville. Pp. 280. (Paris: Libr. Gallimard, 1945.) 135 francs.

appears to have strengthened a conception of education—akin to that which H. E. Armstrong untiringly expounded—much of which was arrived at during the Nazi occupation.

Although, as has been remarked, M. Naville's thesis is specifically directed towards conditions in France, it has implications which should be carefully considered in Britain and indeed in every industrialized country faced with the present-day problems of acute shortage of man-power. Somehow, within the confines of the democratic conception, ways and means must be found of relating man-power more efficiently to industrial and social needs; nothing less than the guidance of labour at every level from the manual worker to the university graduate is in question. Much fundamental and creative thought will have to be given to a critical re-examination of the basis of vocational guidance and selection, in order that the people at large may contribute of their best to the needs of a devastated world, and at the same time enjoy the satisfaction which is the goal of a civilized and progressive community.

RICHTER'S ORGANIC CHEMISTRY

The Chemistry of the Carbon Compounds
By Victor von Richter. Edited by the late Prof. Richard Anschutz. Vol. 3: The Aromatic Compounds. Newly translated from the twelfth German edition by A. J. Mee. Pp. xviii + 794. (New York: Elsevier Publishing Co. Inc., 1946.) 15 dollars.

IN the course of chemical research it frequently happens that an investigator finds himself entering a field relatively unknown to him, for the exploration of which the ordinary text-book is necessarily too sketchy while, on the other hand, the massive detail of Beilstein's Handbook makes it difficult to carry out a rapid initial survey. At such times Richter-Anschütz's "The Chemistry of Carbon Compounds" is invaluable, and we particularly welcome, therefore, the publication of Volume 3 of the latest edition in English. It had been the intention of the publishers that this new edition, although based on the twelfth German edition of 1935, should be revised and brought up to date by Dr. T. W. J. Taylor and Dr. Wilson Baker. Unfortunately, however, only the first portion, some 50 pages of the present text, had been completed when the outbreak of war prevented the continuation of the project. In order to complete the English version, it was then decided to publish the remainder in the form of a literal translation of the German edition. This has been prepared and edited by Dr. A. J. Mee and Mr. M. F. Darken. The bulk of the material is therefore the same as that contained in the German edition of 1935, and for material published during the past ten or twelve years the chemist must necessarily seek elsewhere.

Nevertheless, there are several important changes to be noted in the present volume. For example, the opening pages, dealing with the general properties of aromatic compounds, the determination of the position of substituents, rules of substitution, etc., have been revised by a team of experts, and there is an entirely new account (pages 16–25) of the structure of the benzene nucleus. This has been specially contributed by Dr. T. W. J. Taylor, and in it the reader will find a clear and concise account of this classical problem of organic chemistry treated in terms of the modern outlook. A further innovation of special importance to English readers is that literature references are now given to the original journal in which the information in question was published and authors' names are also indicated. This change makes a great improvement over the earlier editions, in which references were almost exclusively to the *Chemisches Zentralblatt*. So far as can be judged from various test cases applied by the reviewer, the selection of references has been carried out with discrimination, and the user of the book will readily be able to find his way to the most significant papers.

The formidable task of effecting translation has been carried out with conspicuous success, with the result that a clear account is presented of the many and multifarious divisions of aromatic organic chemistry. It is obvious, too, that considerable care and thought have been given to the matter of arrangement and setting out of the sections, with much advantage to the reader, who is thereby enabled to trace with minimum effort the information for which he is searching. The number of formulæ given is adequate and, in the great majority of instances, they have been printed, despite the need for saving space, in forms which display clearly the chemical structure of the molecules concerned—no mean feat in view of the magnitude of the work.

Some slight idea of the comprehensiveness of the book may be gained from the statement that the index alone comprises 80 pages of double columns and contains some 8,000 references. The present volume is clearly one which every research worker in organic chemistry will wish to have in his hands, and it is a pleasure to be able to accord to it the high praise that it is indeed worthy of its dedication by the editors to the memory of August Kekule.

E. L. HIRST

ELEMENTARY METEOROLOGY

Meteorology with Marine Applications
By William L. Donn. Pp. xv + 465. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 22*s*. 6*d*.

THE weather touches our lives at many points, and had we been air-crew personnel or among those concerned with beach landings or, indeed, with many other operations during the War, the effect of weather would have been of great immediacy. The subject is therefore of wide interest, it has been widely practised in recent years, and in consequence has acquired a fairly large semi-popular, introductory literature. This literature is, however, very uneven in quality, as a result presumably of enthusiasm for the subject sometimes outstripping the understanding. Meteorology, if not a difficult, is certainly a very complicated subject, calling for a thorough grounding in the classical branches of physics, particularly of mechanics and heat, and it is to be feared that not a little harm has been done to its students, if not also to the subject itself, by some of its recent expositors. One meets so often a series of false or incomprehensible statements, or, little better, of half-truths such as "hot air rises", "the winds are a consequence

of the pressure distribution", and much other weariness to the spirit of which there seems scarcely any end.

Again, one often reads of the giant strides of progress in meteorology during the last twenty or thirty years, and the impression is created in the learner's mind that here is a compact, integrated body of knowledge. True, there has been some progress but, let us face it, it has been disappointingly small in the clarification of the major atmospheric processes. We have, as yet, only the vaguest of ideas on the causes of formation of tropical storms, extra-tropical depressions and anticyclones (though we know a good deal in an empirical way about their behaviour once formed); we know little about the physical processes which result in rain as opposed simply to cloud, or of the intensity of rainfall which will result from a given situation; we are largely in the dark as to processes of radiation in the atmosphere (though Prof. G. M. B. Dobson has lately cleared the matter to quite an extent so far as the lower stratosphere is concerned); and so one could go on. Not that these are reasons for despair; indeed, they make the subject all the more exciting and worth while for advanced study. Moreover, we are getting nearer the stage of having adequate tools and enough of them for a proper three-dimensional investigation. One does not, of course, expect introductory books to discuss at any length the unsolved problems of a subject; but it is as well that expositors should be thoroughly aware of the major deficiencies, even, one might say particularly, for a sound elementary presentation.

This said, the reviewer turns to a new introductory but, in intention, rather comprehensive book with some trepidation for what shall be found, and is mainly disappointed, indeed often shocked, while fully acknowledging that the author, W. L. Donn, has in some respects given an original treatment. The accent so often in the past having been aeronautical, this new book enlists marine interests though it is also intended as a general exposition, "simpler and more readable in style than is usually encountered . . . of value to the occasional lay reader, as well as to the mariner and student", with academic style avoided as much as possible. In parenthesis, is it really the case that a matriculated student—and one of lowlier attainment cannot be expected to look beyond the title page and the photographic illustrations—shuns simple algebraic equations when their use adds much crispness to a presentation? The author sets out to cover what is now generally termed synoptic meteorology, providing a descriptive treatment reinforced (*sic*) by physical explanations of many of the phenomena and concluding with quite welcome chapters on optical phenomena and the oceans. As descriptive meteorology the book is not unsuccessful, though not free from error, is notable for a very full account of tropical cyclones and is aided by a handsome collection of mainly new photographs. But the physics is often very bad, and for that reason it cannot be recommended to the student coming to the subject for the first, or indeed any early, time. As examples one notes: one reason for the decrease of temperature with height is said to be the decrease of density with height—"the less the air, the less the heat that can be held in the air, and the lower the temperature falls" (p. 28); the theory of the psychrometer and the effect of aspiration is stated falsely (p. 38); water vapour is said to produce an equable temperature by virtue of its absorption of solar radiation (p. 44); the effect of wind speed on evaporation is falsely stated (p. 45), as also the refraction of isobars at a front (p. 270); and so on. Indeed, whenever the words 'clearly' or 'hence' are used, one quickly comes to expect a *non sequitur*.

There is a useful appendix of average monthly weather summaries for the principal ports and islands of the world, and another giving films which have been prepared to illustrate various branches of the subject. P. A. SHEPPARD

PLATO AND THE PRESENT DAY

Plato's Theory of Man

An Introduction to the Realistic Philosophy of Culture. By John Wild. Pp. x + 320. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1946.) 28*s*. net.

THIS study of Plato's philosophy is on novel and interesting lines. Prof. John Wild maintains that most modern commentators have approached Plato in the wrong way. "An almost exclusive emphasis was laid upon his epistemology, but his thoroughgoing and elaborate attempt to lay bare the hierarchical structure of human culture, including art, life and thought, and his impassioned attack upon that primary cultural disease of *sophistry*, by which this hierarchy is inverted, to which so many dialogues are primarily devoted, were either disregarded or dismissed as the petulant defense of an archaic class society. No one dreamed that the progress-phenomenon of the nineteenth century, vast proliferation of the subordinate techniques together with sophistic decay of the higher arts, had an analogue in the great fifth century of ancient Greece, and that Plato's pointed and profound diagnosis of this as the primary cause of barbarism and tyranny might have a modern as well as an ancient factual verification" (p. 4).

Prof. Wild is almost certainly right in his statement of the general aim of the dialogues, and his detailed exposition brings out a number of valuable points often overlooked, though he does tend to make Plato's thought appear simpler and more uniform than it actually is. Still, there is a very great uniformity so far as Plato, like his master Socrates, was attacking the prevalent intellectual and moral disease of sophistry or, as we might say, quackery; the sham masquerading as the genuine, the lower as the higher, the worse as the better. The errors of sophistry are dangerous, as Plato saw, because they are not just errors; they have their roots in reality, of which they are perversions. But since they are perversions, if they prevail they distort human society, invert the right order of things and finally destroy true education and statesmanship, which are the basis of a well-ordered society. The early stages of perversion display a façade of truth and look well enough; it is only later on that their falsity comes to the surface.

Plato had seen how the liberal humanist, Protagoras, showed the way to the brutalitarians, Callicles and Thrasymachus. We can see how the fine fervours and brave intentions of nineteenth-century romanticism and idealism led by a natural process to Fascism and Nazism. Plato's indictment of his own times is highly suggestive for ours, as Prof. Wild emphasizes, but, as he scarcely seems to notice,

Plato has really nothing positive to say. He can show us the evils of perverted or sham education and statesmanship, and explain how beneficial the unperverted might be, but these unperverted forms he cannot show us. Of course Plato is in no worse case than anybody else; he labours under a defect of human thought. The history of Christian doctrine illustrates the difficulty. When a heresy has appeared, it becomes possible to say that the orthodox doctrine is not that; but until error has been formulated, truth is indefinable and even afterwards definable only by negation. Within certain restricted spheres of knowledge where errors are technical errors, they are avoided once they have been exposed as such, and in those spheres knowledge is cumulative and progressive. Elsewhere each generation is liable to be deceived by the old shams and commit some of the old errors.

If Plato is right and there is a hierarchy of the human arts or forms of productive knowledge, and if education and statesmanship are the highest of these, in virtue of determining the ends of life to which the subordinate arts supply means, then perversion seems inevitable. Only the subordinate arts expand and progress, and means are substituted for ends. The ship, to develop Plato's old simile, is never in the hands of a genuine pilot who knows how to take her into harbour, because there are no pilots. She is in the hands of people who suppose that since they know something about seamanship they understand pilotage too. One advises letting go the anchor, because when you are anchored you know where you are; another advises drifting with the tide, because Nature never errs or progress is inevitable; another recommends going full speed ahead, because speed can keep you off the rocks. As the anchor does not reach the bottom and the engines frequently break down, it is the second who generally has his way. A. D. RITCHIE

HISTORY OF THE ZOOLOGICAL MUSEUM, COPENHAGEN

Zoologisk Museum i København gennem tre aarhundreder

Af Ragnar Spärck. Pp. 110. (København: Ejnar Munksgaard, 1945.) n.p.

THE histories of the important museums of Europe have followed the same general lines. They have had their origin in the 'cabinets of curiosities' formed by the aristocracy and the 'savants' during the late seventeenth or early eighteenth centuries. As their name implies, such 'cabinets of curiosities' included the most varied articles collected from all parts of the world through the help of travellers, ship's officers, Colonial officials and learned colleagues. It was mainly during the last half of the eighteenth century that many of these collections were obtained by the State or university, and the idea of public ownership of such collections became generally accepted. During the early nineteenth century, numerous museums were started by learned societies and institutions, but towards the middle of the century these small museums began gradually to be absorbed by the main museum. Local museums still have an important part to play, but in order to do good systematic work, important specimens must be centralized in one museum with a good comprehensive library and a fully trained staff of experts.

The history of the Zoological Museum in Copenhagen is no exception to the general trend, and in this book Ragnar Spärck has traced its history from its origins in the collections of Ole Wormius formed between 1623 and 1625, the Royal "Kunstkammer" and other private collections of the eighteenth century, to the modern up-to-date museum of the present day.

The history of an important zoological museum is of interest not only to the historian but also to the working systematist who is so often concerned with the origin or whereabouts of types and other important specimens. It is a pity that this book, being written in Danish, will not be available to many who would otherwise find it interesting to read and invaluable for reference.

Besides giving a detailed history of the collections at Copenhagen, there are many interesting biographical details of officials of the Museum and benefactors to the collections, and at the end of the book there is a chronological list of all who have been connected with the Museum during its long history.

BRITISH INSECTS

A Check List of British Insects

By George Sidney Kloet and Walter Douglas Hincks. Pp. lix + 496. (Heaton Chapel, Stockport: Kloet and Hincks, 1945.) *52s. 6d.*

THIS work is an important contribution to the study of British insects; the need for such a catalogue has been felt for many years. It is curious that the earliest list of British insects was by a German named Johann Reinhold Forster, and was printed at Warrington in 1770. A photographic reproduction of the title page of this work forms the frontispiece in the present book. The last list of British insects was by the Rev. F. O. Morris and was published eighty-one years ago. It is so rare nowadays that Messrs. Kloet and Hincks mention being unable to see a copy.

It is difficult for anyone who is not a taxonomist to realize the practical difficulties and the critical abilities required to produce a list of more than 20,000 species of the insects native to Great Britain. Twice the Entomological Society of London has sponsored the task—the first effort was made in 1870 but died out after seven years. The second effort was started in 1934, and since that time it has only listed about one-twelfth of the fauna, although due allowance must be made for the intervening war years. Messrs. Kloet and Hincks' work is not a mere compilation but a genuine effort to clarify the taxonomy and nomenclature. Some 4,714 genera and 20,024 species of British insects are included, to which may be added a further 220 species which are doubtful or casual. In every case the name of the describer of each species is given along with the date: the same details are also given with respect to the chief subspecies, etc.

We express our admiration of this most useful list and all the self-sacrifice it has entailed to compile it. Our hope is that sufficient encouragement will be given to the authors to keep pace with modern developments and so to be able to issue a revision list when necessity demands it.

SCIENCE AND ETHICS*

By Prof. H. DINGLE
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THE problem of the relation between science and ethics has been very much to the fore in recent years. Let me say at once that I am not among those who regard ethics as a department, or even a possible department, of science. It seems to me to stand right outside the scope of scientific investigation. I will explain why presently, but I may say here that it is not because I have some other kind of solution of the ethical problem to offer. I have none; and all that I can hope to do is to state a question and not to give an answer. I will try to isolate the problem and show why in my view it fails to qualify as a science.

First of all, then, let me state as briefly and clearly as I can what I mean by the ethical problem. It is this. We constantly find ourselves in situations in which we are compelled to choose between a number of alternative actions, including inaction, that are open to us: the problem is—How shall we make the choice ?

I want to emphasize that the statement of the problem belongs to the very essence of it. Probably few would feel an immediate impulse to quarrel with the statement I have given, yet it seems to me that a very large fraction of the literature of the subject is concerned not with this but with some other problem which at first may seem identical but is actually quite different. It is therefore not a mere preamble but a plunge at once into the heart of the subject to expose and dispose of certain alternative statements which form the theme of many current discussions passing as discussions of ethics.

First, the problem is not that of determining, after I have acted, why I have acted in that way. Dr. C. H. Waddington, for example, whose recent book, "Science and Ethics", has provoked much controversy, seems to think that this is identical with the ethical problem as I have stated it, for he writes[1]: "I cannot see that there is any real distinction" between the problems " 'how did I make my ethical choice ?' and 'how shall I make it now ?' ". To me these questions are quite distinct, and the difference is important because I can agree that the former—"how did I make my ethical choice ?"—is a scientific question, susceptible in principle of a scientific answer, though it may often prove too difficult to solve in particular cases, but I cannot agree that the latter is. I am quite prepared to admit that every observable event, in human behaviour as well as in the behaviour of stones and stars, is open to scientific treatment and correlation with other events; and if, to choose a purely imaginary example, someone proposed a theory according to which the action of a human being in any circumstances was a determinable function of his age, colour of hair, rate of pulse, and a number of other stated measurable quantities, I should be prepared to admit the possibility that this theory might be valid with regard to every human action that has yet been performed. But that would have nothing to do with the ethical problem, for that problem is *essentially* concerned with future and not past action. After I have verified the theory in question and calculated what it requires me to do in the problem now before me, I am not relieved of the task of choice. I find myself able to violate the practice of the past and render the theory only an approximation to the truth by introducing another essential variable—my knowledge of the theory in question—which did not operate before because no one had such knowledge. For this reason I cannot regard the ethical problem as being soluble by any kind of analysis of past actions.

Again, the question is not "Which of the alternative actions is the right one ?" but "How shall I choose between them ?". There are two reasons why this difference is important. First, any act in itself is ethically neutral; it is the motive behind it that gives it its ethical quality. That is fairly obvious, though it does not prevent many writers on ethics from devoting much irrelevant discussion to the moral quality of acts, but the second reason is more profound. If one asserts of an act—not merely the bare act just considered, but an act performed in stated circumstances and with stated objects in view—that it is 'right' or 'wrong', one immediately comes up against the question: What is the criterion by which one can determine its rightness or wrongness ? and no one has yet been able to discover any generally acceptable criterion.

This is the ground of the logical positivists' characterization of ethical judgments as 'nonsensical'. As an example let me quote one of the leading representatives of this school, Rudolf Carnap. Carnap agrees[2] with the distinction I have already drawn between past and future actions, and eliminates the study of the causes of past actions from the discussion, but in designating what remains as the problem of determining what it is right to do instead of how to decide what to do, he changes it from an inescapable dynamic problem to an optional static one, and he has no difficulty in showing that it is then a meaningless one. For in order that such a statement as, for example, "killing is evil" shall have a meaning it must entail some consequences which can serve as a test of it, just as the statement "prussic acid is poisonous" can be distinguished from its opposite, "prussic acid is not poisonous", by administering some and observing what happens. Now there is no such test for distinguishing "killing is evil" from "killing is good". We may kill a man, but the result throws no light on which of the contradictory propositions is true. "From the statement 'Killing is evil'," writes Carnap, "we cannot deduce any proposition about future experiences. Thus this statement is not verifiable and has no theoretical sense, and the same thing is true of all other value statements."

This argument seems to me unanswerable. All that I would add is that it is quite irrelevant to the

* Substance of a paper read on July 5 before the Conference on "The Problems of Communal Life: the Ethical and Scientific Approach" organized by the British Social Hygiene Council.

ethical problem. To take the particular example which, I suppose, inevitably occurs to those of my generation since it faced us all in 1914, let us apply it to the problem, "How shall I decide whether to join the Army or to strive for immediate peace ?" It tells us at once that the question "Is it right to join the Army ?" is nonsensical because it has no possible answer with verifiable implications, but if we had realized that in 1914 it would not have helped us in the least. We should still have had to choose our course and we should still have needed to know how to make the choice. We should have answered one problem satisfactorily, but it would not have been the important, the inescapable problem.

There is yet another distinction which I think it is necessary to make. Having isolated our problem, "How shall I choose ?" from the pseudo-ethical problems, "How have I chosen in the past ?" and "Which action is right ?", we must isolate it also from the still more nearly related problem, "Which act shall I choose ?". This statement of the question has the necessary reference to the future, and it escapes the logical positivists' criticism because it does not presuppose the assignability of unaccredited qualities like 'rightness' or 'wrongness' to acts, but it is not the ultimate problem because it arises afresh on every occasion and, in the absence of an underlying principle, admits of an answer compatible with any inconsistent general line of conduct. It is such a principle that is the ultimate object of our search, and when we ask "How shall I choose ?" we are actually groping after an innate source of conviction that when we make such and such a choice we are making the one which has a unique sanction.

It is at this point, I think, that we can best make the comparison between ethics and science, and the insurmountable barrier between them seems to me to lie in this fact, that in science we have such a source of conviction and in ethics we have not. Science rests ultimately on a basis of absolute certainty ; ethics, so far at least, has not in general found any basis at all. Let me try to explain this more fully.

When I say that science has a basis of certainty I do not, of course, mean that every scientific statement is certain, or, indeed, that any is necessarily so. What I mean is that if a scientific statement is challenged it may be referred back to certain evidence, that evidence may itself be subjected to scrutiny, and so on, until ultimately we arrive at something fundamental the validity of which is beyond question. Science can therefore advance with confidence that although it may make mistakes they are not irreparable, and that even although its most trusted structures may come tumbling about its ears, it cannot finally collapse because underneath are the everlasting arms. They are two—reason and experience ; on these twin supports science has an indestructible foundation.

By its very nature science consists of the rational ordering of the facts of experience. We accept as data that which we experience—not only sensations, as in the older sciences, but, in the science of psychology, emotions, passions and hallucinations as well. We represent them by concepts which we define in such a way as to facilitate the expression of rational relations between one experience and another, and the derivation of those relations then becomes a matter of pure reason. The point I wish to stress is that when we have admitted to the uttermost limit our liability to error there remains a residuum of indubitability consisting of our sensations themselves and the ultimate elements of rational necessity. Let me deal with these in turn.

What do I mean when I say that an experience is indubitable ? I do not mean that any particular sentence by which I express the fact of that experience is necessarily defensible, but simply that there is something of which I am conscious which I cannot deny and which, correctly or incorrectly, I try to convey by that sentence. Let us suppose that when walking by night along a country road I am conscious of a faint point of light and I say, "I see a star". Now it may happen that on walking further I realize that it is getting larger and brighter too quickly for a star, and I say, "No, it is not a star, it is a roadside lamp". But now I go further and find that there is no lamp where I expected one and I no longer see the light. I then say, "There must be something wrong with my eyes, for the sensation has no external physical cause ; I must have my eyes examined". Accordingly I have them examined, and they are found to be in perfect order. I am then forced to say, "There must have been some psychological cause for this illusion ; either I was obsessed by some emotion which caused me to think there was a lamp where there was none, or else perhaps I am even now suffering from a trick of memory which makes me think I had the experience of seeing a light whereas at the time I was not conscious of any such experience".

Now in this example I have been forced step by step to change my account of an experience to make it rationally compatible with subsequent experience, but what in the end I cannot deny at all is the ultimate fact that I am conscious now of a memory of a certain kind, namely, of the kind that I usually describe as seeing a light. My successive changes of interpretation are, from the scientific point of view, simply changes of *classification* of the experience. When I said I saw a star I was contributing to the data of astronomy. When I said I saw a lamp I was contributing to the data of local geography. When I said my eyes were out of order I was contributing to the data of physiology. When I said I was suffering from a mental affection I was contributing to the data of psychology. Any one of my statements might, apart from the subsequent evidence, have been 'right' or 'wrong' but, from the very nature of things, I am unable to obtain any evidence at all that can possibly destroy my present consciousness of having seen a light. That is what I mean by saying that the whole world of experience, which constitutes the data of science, has an ultimate indubitability. It cannot be denied ; it can only be reclassified.

There is a similar basis of certainty in the process of reasoning. In arguing from premises to conclusion we may make mistakes, but when the process of deduction is analysed more minutely we either come to a step which we recognize "does not follow" or, if not, we are forced to admit that the reasoning is sound. It is true that there is much discussion at the present time about the possibility that the rules of logic are mere conventions which might have been chosen differently, and that alternative and equally valid logics are possible, but all that does not alter the fact that there is a residuum of inescapable necessity in the process of reasoning to which we must perforce assent. Logic is merely an attempt to

formulate the principles of reasoning, and alternative logics are alternative formulations, but unless there were some implicit basis of agreement underlying any formulation at all that is possible in any language, we should not be able to discuss alternative logics as in fact we do. The attempt to prove that a particular system of logic or set of fundamental "laws of thought" is self-consistent assumes that those to whom the proof is addressed are capable of being convinced by it, and that means that they share with the prover the acceptance of some ultimate and universal rationality too obvious to be questioned and too deep to be expressed, something that exists between the lines of even the most minutely detailed argument and without which the argument could not hold together.

These two ultimate certainties, then, are the indestructible elements of science, and give to the scientific worker the conviction that whatever disaster may come to the structure he builds, the bricks of experience and the mortar of reason must remain unimpaired. It is, I think, one of the most momentous facts of our nature that we have no such conviction concerning the course of action we should choose. We cannot escape action, but we have no "inner light" which serves to give us the certainty that there is an unquestionable principle of right behaviour to which we can approximate. Take any moral precept at all—say the rule, "Love thy neighbour as thyself", or any other you please—and, however strongly you are inclined to advocate it, you do not feel that its truth is self-evident, that anything not in accordance with it is inconceivable as a right rule of behaviour. It is at least arguable that since one is oneself and not another there should be some differentiation between one's love of oneself and that of another, and because that possibility is conceivable we have not the same inner compulsion to accept the rule that we have to accept the fact of our experience or the necessity underlying the process of pure reasoning. In that fact lies the essential peculiarity and the whole basic difficulty of the ethical problem.

I know, of course, that many people do feel an irresistible urge towards a particular type of conduct which is for them of the nature of a "categorical imperative", comparable with the compulsion to assent to a logical argument. Such people have no fundamental ethical problem. It might be argued that this is the natural state of a healthy human being, and that those who have no immediate perception of what they should strive towards in any given situation are defective in some respect. I cannot, however, accept this hypothesis, because between the conviction of ethical rightness and the convictions of logical necessity and the fact of experience there is this essential difference, that the former may, and in fact frequently does, lead to conflict, and the latter cannot do so. The principles of reasoning are universally the same; the conviction that "whatever is, is" is not confined to a sect but belongs to the whole race of rational creatures. The certainty of experience, on the other hand, is at the opposite extreme and is essentially individual; the certainty of my experience of seeing a light is quite independent of any experience which the rest of the world might have, and I cannot escape but only reclassify it if my companions have no such experience. But there is no possibility of conflict between us. Our experiences may be dissimilar, but so long as we do not go beyond the assertion of their mere existence they cannot possibly contradict one another. But in the moral sphere there *is* conflict. If I strive for war and my companion for peace we inevitably work against one another, and any claim that an ethical "categorical imperative" is an attribute of a normal human being must be accompanied by the admission that human beings are by nature in necessary opposition and the only arbiter is brute force.

We must acknowledge, then, that no final sanction exists for any particular answer to the question, "How shall I choose what to do?" I have called this a momentous fact, and I think no word is strong enough to exaggerate its importance. It means that at bottom all systems of ethics and all exhortations to a particular kind of conduct must rest on a dogma which it is useless because impossible to try to justify. Consider, for instance, the rule that one should act always for the greatest good of the greatest number, and let us suppose for simplicity (although, in fact, it is not true) that we can agree about what constitutes the "greatest good". One may challenge this with the question, "Why the greatest number? Why not work for the perfection of the best at the expense of those who in any case cannot be made much of, instead of for a uniform mediocrity? Why pander to a second-class humanity and not try to surpass it by a first-class superhumanity?". If there is any answer to this question it can only take the form, "Because the greatest good of the greatest number is more in accordance with—some other principle", and then it is that other principle that becomes the fundamental directive of action. And because of the non-existence of an unquestionable basis of belief this process goes on for ever, or else we must come to some statement at which we stop and say dogmatically: "This is right because I say so; I refuse to give any other reason".

Not only is this a momentous fact; it is also one which is almost universally ignored. It would make for great clarification of thought if every book and every article which purported in any way to be a guide to conduct were to start with an explicit statement of the fundamental dogma on which it is based, and then restrict itself to making deductions from that dogma without wasting time trying to justify it. One would then know at once if the dogma was acceptable to him, and if not he could refrain from reading further except perhaps as an intellectual exercise. Very few books do, in fact, achieve or even attempt to achieve this ideal. Either they do not explicitly state their basic thesis, which one has with difficulty to discover during the reading, or else, having stated it, they attempt to establish it by an appeal to reason. All this implies a quite inappropriate attitude to the matter, and inevitably induces in all but the most astute readers the unconscious expectation of a conclusion which is in the nature of things impossible. The only discussion of the ethical problem that is of the slightest use to anyone is that which is founded on a dogma which he is prepared to accept. Such a discussion can be quite scientific in character so long as the dogma is not called in question. If, for example, one accepts "the ethics of the New Testament", then it becomes a matter of scientific investigation to determine what the ethics of the New Testament may be, and of reason to deduce what course of action it demands in the circumstances of our time. But the question, "Why should I accept the ethics of the New Testament?" only leads one by a series of arbitrary steps along an endless path of verbosity.

Space forbids any attempt to estimate to what degree our thinking and practice are perverted by lack of recognition of this fundamental fact. One example must suffice. In the Second World War it was decided that release from military service should be granted to conscientious objectors, and tribunals were created for the purpose of granting such release to all who could establish a claim thereto. It was then the obvious duty of the tribunals to satisfy themselves in each particular case whether or not the man had a conscientious objection to military service, and since it is not given to human beings to see directly into the inner convictions of others, the only relevant evidence was the testimony of trustworthy persons who knew the man and could throw what light was available on his convictions concerning the point at issue. My experience of their proceedings was not extensive but, such as it was, it showed quite clearly that this formed a small, not to say negligible, part of their activities. What usually happened was that the applicant was questioned on some point of doctrine, and something of the character of a discussion arose between him and the members of the tribunal. Since he was almost invariably inexperienced and in a somewhat nervous state, while the tribunal consisted of maturer brains sharpened by previous encounters of the same kind and possessed by opposite convictions, it usually happened that the discussion ended in the applicant's discomfiture, whereupon it was decided that his claim was unfounded. It was not his conscience that was tested but his reasoning or, rather, debating powers, and release was often granted not to the man who felt the strongest compulsion to refuse to fight but to the man quick-witted enough to escape from the dialectical traps that were set for him; and that because the tribunals had not the penetration to see that a fundamental moral conviction is not the product of a series of syllogisms.

The fact that morality cannot be based on experience or on reason leaves open the question what its basis may be. We are still faced with the problem, "How shall I choose ?", and I have no solution to offer. We do not without reluctance accept a conclusion which leaves the most fundamentally important thing in our lives a matter of caprice, and I do not offer it as a gospel but simply as an inescapable fact. We are such that we must act, and our acts determine the future, and except for a few, individually fortunate but at variance among themselves, we have no indefeasible source of conviction that one choice is better than another.

It is not within my province to discuss the efficacy of religion in this situation, but I might perhaps point out that the considerations I have advanced indicate clearly enough the sphere within which, if anywhere, religion must operate, and also that, within that sphere, it can meet with neither opposition nor support from science, for science is excluded therefrom. Whatever contribution religion has to make must be concerned with the fundamental dogma which must be accepted before scientific consideration of ethical problems can begin. I would add only this. In stressing the dogmatic character of the possible contribution of religion I am speaking only of ethics and not at all of theology; I see no reason for believing that theological statements are beyond rational discussion.

[1] "Science and Ethics", p. 101.
[2] "Philosophy and Logical Syntax", p. 23.

APPLICATION OF FERTILIZERS TO AN OPEN SEA LOCH

By F. GROSS, J. E. G. RAYMONT, S. R. NUTMAN and D. T. GAULD

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INVESTIGATIONS carried out at Loch Craiglin, a small arm of Loch Sween[1], have shown that the productivity of an enclosed sea loch can be raised by the addition of sodium nitrate and superphosphate, just as the productivity of a laboratory culture or a freshwater pond can be increased by the addition of plant nutrients. However, the hydrographic and biological conditions in Loch Craiglin were rather atypical: the small depth, the fluctuating and, on the whole, low salinity in the upper layers, the high hydrogen sulphide and low oxygen concentration in the deeper water, the profuse growth of seaweed and eel grass, the soft muddy ground, all were factors which made this experiment a severe test.

In 1944, with increased grants from Imperial Chemical Industries, Ltd., the experiment was extended to Kyle Scotnish, another arm of Loch Sween. In one respect the experiment in Kyle Scotnish was new and not a mere extension of the Craiglin experiment; no dam was erected and the Kyle was left open to the main body of Loch Sween in order to test the possibilities of fertilizer application in an unenclosed area of the sea. One of our main tasks was to study the exchange of water taking place between the Kyle and the main loch, and thus the extent of loss, or rather the rate of dispersion, of the fertilizers added.

Kyle Scotnish covers an area of about 160 acres and has a maximum depth of 21 metres. Near its connexion with the main loch and for a distance of several hundred metres it is very narrow, at one place not more than 100 metres wide. It then widens out into two large basins (South and North Basin). Sailean More, a parallel arm of Loch Sween, was used as a control area for plankton studies.

Distribution of Fertilizers

During the first one and a half years 38 cwt. sodium nitrate and 8 cwt. superphosphate were distributed, usually at monthly intervals. Afterwards, 30 cwt. ammonium sulphate were added per month in the place of sodium nitrate. This combination of fertilizers, among others, has been tested in Loch Craiglin by Marshall and Orr (personal communication) and has given satisfactory results.

On several occasions the fertilizers were distributed only in the North Basin of Kyle Scotnish in order to obtain a high concentration of nutrients, initially confined to a small area, and to study the subsequent extent and rate of dispersal of the nutrients along the whole length of the loch. Thus the phosphate concentration itself was used as an indicator of water movements.

The phosphate was gradually carried down the loch and became dispersed over the whole length of Scotnish in the course of one to four days, but its concentration tended to remain higher in the North Basin than in the South Basin. The bulk of the dissolved phosphate was used up in about a week. From the amount of superphosphate added and the concentrations found afterwards in water samples, we estimated that not more than a quarter of the phosphate was

dissolved immediately at fertilization, but some of the phosphate which sank to the bottom went into solution later.

All our data concerning phosphate distribution suggest that under normal weather conditions the transport of fertilizers out of our limited area, due to tidal water movements (with a range of 4 ft.), was not serious.

Plankton Production

On several occasions the phytoplankton, especially diatoms, responded very favourably to fertilizer application. On other occasions, particularly during the summer months, there seemed to be little, if any, response to fertilizer distribution.

The reason for the apparent absence of phytoplankton increase in Scotnish following fertilization was the grazing activity of the zooplankton. Before fertilization began in Kyle Scotnish, there was no significant difference between the plankton populations in Kyle Scotnish and in the control area, Sailean More. But from March 1944 the zooplankton of Kyle Scotnish became steadily more abundant. In May there were 10 animals per litre in Sailean More, 34 in the South Basin of Scotnish and 62 in the North Basin. In July there were 53 in Sailean More, more than 200 in the South Basin of Scotnish and more than 373 in the North Basin. Each component group increased more or less proportionately with copepods forming the bulk of the zooplankton in both fertilized and control areas. Only on a few occasions was the zooplankton of Sailean More richer than that of Kyle Scotnish—and then only when populations were very low in both areas—while throughout the greater part of 1944 and 1945 the population density was considerably greater in Kyle Scotnish than in Sailean More.

Fleming[2] draws the important distinction between 'total productivity' (the total number of phytoplankton organisms formed from the original population) and the 'increment' in population (the difference between the initial population and the population at some later time). Only in the absence of grazing will the total productivity be the same as the increment in population. The difference between the total productivity and the population increment, when caused by grazing, has been called by Fleming 'yield'.

We can therefore say that during the period of great zooplankton production the phytoplankton yield utilized for the maintenance of the zooplankton was very great and the increment of population correspondingly small. On the occasions when zooplankton in Kyle Scotnish was poor and conditions for phytoplankton growth favourable, the increment of phytoplankton population following fertilization was very great.

Nannoplankton or μ-flagellates occurred in Scotnish in lesser numbers than in Loch Craiglin, varying roughly from 200 to 1,500 cells per cu. mm.

Benthic Microflora

It was found occasionally that water samples taken near the bottom contained considerably larger numbers of μ-flagellates. Finally, high population densities of these were found in the mud surface. No accurate figures can be given until the methods of distinguishing some of the very small μ-flagellates from bacteria have been improved. They are apparently not confined to quite shallow waters, since they were also found in mud taken in Loch Sween at depths down to 22 fathoms.

Since a large fraction of the fertilizers sinks down to the bottom of the loch, attention was given to the question of their utilization at or just above the surface. During the past two years trays with glass slides were put out in Kyle Scotnish and in unfertilized areas of Loch Sween. They were left on the bottom in depths from 1 to 10 m. for varying lengths of time and were colonized by a benthic microflora, in particular pennate diatoms. Mr. Smyth has recently taken over the task of analysing the material collected. About eighty species of bottom diatoms can now be distinguished, though their identification presents some problems. The diatoms have settled on the slides in densities up to 600 per sq. mm. and there are indications that fertilization has brought about an increase in the population density of these diatoms. It is noteworthy that a large proportion of them are 10μ or less in size, that is, sufficiently small to serve as food for most particle-feeders among the bottom animals.

These observations suggest that the mud surface represents an important region of plant production, and that in coastal waters down to considerable depths part at least of the fertilizers sinking to the bottom would be converted into organic matter by μ-flagellates and bottom diatoms at or near the mud surface.

Bottom Fauna

The task of following up the changes in the bottom fauna of Kyle Scotnish was much more difficult than in Loch Craiglin because of the much larger area concerned and the much greater variety of the fauna. Unlike our experience in Loch Craiglin, not every station showed an increase in bottom fauna. Comparing the winter population in 1945 and in 1946 with that in 1944, before the application of fertilizers, 7 out of 27 stations showed a decline in both years, 6 a decline in one year (mostly in 1945) and an increase in the other (1946), and 14 an increase in both years. At some stations the increases were very striking. A comparison of the average populations, expressed in numbers per sq. m., shows an increase in the course of two years from about 640 in 1944 to 1,420 in 1946. In two further series of samples the average increase in population during 1944–46 was 3 times, from 640 to 1,950 per sq. m. (summer sampling), and 4·5 times, from 680 to 3,160 per sq. m. (winter sampling), respectively.

Shore Fauna

As regards the shore fauna the most striking phenomenon observed was an extremely heavy settlement of the common mussel at the head of Kyle Scotnish during the last two years. This is particularly significant because the breeding stock of larger mussels (more than 40 mm.) is found in greater concentrations in Sailean More and in Linne Mhurich (a third arm of Loch Sween) than in Kyle Scotnish. For each large mussel there were during the summer of 1945 between 900 and 3,000 mussels of less than 10 mm. in Kyle Scotnish, about 0·5 in Linne Mhurich and 10 in Sailean More. There is also some evidence that the mussels have been growing more rapidly in Scotnish than outside.

Fish Growth

The natural fish population in Kyle Scotnish is rather sparse and consists, apart from small fishes,

of seasonal mullet, sea trout, saithe, flounders and occasional plaice.

In spring 1944, Kyle Scotnish was stocked with eggs of plaice, cod, haddock and witch, which were obtained by stripping ripe fish on board fishing boats in Loch Fyne. Some young plaice caught in the summer and autumn of 1944 showed very promising growth, and flounders more than one year old showed in the pattern of their otoliths that they had grown better in 1944 than in 1943. But the numbers of fish caught were very small.

In the spring of 1945 between one and two million plaice eggs and fry, produced in a hatchery erected in the neighbourhood at Carsaig Bay, were released in Scotnish, and samples of fish obtained throughout the summer and autumn.

By the autumn of 1945, plaice of age-group 0 (as determined by otolith examination) attained a mean size of 13·2 cm.–25 gm. which corresponds to approximately five times the normal weight increment. At the same time Group I plaice reached a mean size of 20·4 cm.–100 gm. Compared with a good growth to 15 cm. on normal grounds, they had put on approximately three times more weight.

Group 0 flounders grew to a mean size of 9·5 cm.–10 gm., which is an improvement by about 400 per cent in weight over their growth on normal grounds. Group I flounders attained a size of 21·6 cm.–116 gm., approaching the best growth observed in Loch Craiglin[1].

There is, however, good evidence that the mean sizes are not true indices of growth-rate, but rather under-estimate the improvement in growth under conditions of fertilization. Examination of the otoliths and analysis of size distribution of successive catches indicated an appreciable immigration of fish into Kyle Scotnish, causing an extremely wide range of size in fish of the same age. For example, 135 Group I flounders, caught in June, ranged from 7 to 23 cm. Moreover, in the summer some of the large one-and-a-half year old specimens—old inhabitants of Scotnish—moved out of the fertilized loch following their habit of offshore migration. Hence the range narrowed down and the increase in the mean size during that period was largely due to the growth of the recent immigrants.

No data on the growth-rate of round fish could be obtained as both cod and saithe stay in Kyle Scotnish only during the first summer of their life.

Conclusions

The migratory habits of the fish set a limit to any further exploration of Loch Sween for the furtherance of marine fish cultivation. To this must be added the fact that in our experience heavy stocking with the aid of hatcheries is not practicable owing to the low survival-rate of fry. It is estimated that in 1945 only about 2,000 plaice survived until the summer, that is, only about 1–2 out of every 1,000 fry released from the hatchery.

Therefore any future experiment or development of marine fertilization will have to be done in an area with a natural rich fish population and an area which contains those habitats to which flatfish tend to move in their offshore migration, that is, waters of greater depth. This implies an experiment on a rather large scale which alone could lead to an assessment of the economics of fertilizer distribution in the sea.

The investigations at Loch Sween were begun in 1942 in the hope that application of fertilizers to enclosed areas of the sea would lead to an increased yield of fish and thus contribute to the stores of home-grown food during the War[3]. The original aim has been supplanted by the more attractive prospect of increasing productivity in the open waters. Taken over all, the results so far obtained have given evidence of the beneficial effect of fertilizers on plankton, bottom fauna and fish growth, in an open as well as an enclosed sea loch—evidence as consistent as could be reasonably expected considering the complexity of the factors involved. A good deal of research remains to be done which cannot be done at Loch Sween. But, though the goal, that is, increased food production from the sea, has not yet been reached, no fact or factor has emerged which would suggest that fertilizer application has been a wrong approach to marine cultivation.

It is obvious, however, that in the sea, fertilizer application does not lend itself to private commercial development. There is no private ownership of the waters of the sea, and any raising of the fish crop would have to be done on a national and, at a later stage, even on an international basis[4]. Two weighty reasons may be advanced why the work, initiated at Loch Sween, should be continued in a suitable area under Government auspices. (1) In view of the world shortage of food the application of readily available industrial products—ammonium sulphate and superphosphate—for the raising of the fish crop would, if proved to be economical, be ideally suited to present-day conditions as it would not involve greatly increased demands in labour. (2) Russell[5] and Graham[6], discussing the overfishing problem, have recently emphasized that sea fisheries under present conditions have reached, if not overreached, the limits of profitable yield. A large-scale test of the effect of fertilizers on a natural feeding ground would show if fisheries have not at the same time reached a threshold from which a new and enhanced level of productivity might be attained by the addition of plant nutrients.

[1] Gross, F., Raymont, J. E. G., Marshall, S. M., and Orr, A. P., *Nature*, **153**, 483 (1944), also separate papers by the same authors in *Proc. Roy. Soc. Edin.*, B (in the press).

[2] Fleming, R. H., *J. du Cons.*, **14**, 210 (1939).

[3] Gross, F., *Nature*, **148**, 71 (1941).

[4] Ritchie, J., *Nature*, **154**, 275 (1944) and **154**, 832 (1944).

[5] Russell, E. S., "The Overfishing Problem" (1942).

[6] Graham, M., "The Fish Gate" (1944).

GEOPHYSICS OF THE IONOSPHERE

A GEOPHYSICAL Discussion dealing with the ionosphere was held in the rooms of the Royal Astronomical Society on May 31, with Prof. S. Chapman in the chair.

Opening the discussion, Sir Edward Appleton (Department of Scientific and Industrial Research) pointed out that the literature of the ionosphere has now become very extensive. Information about the ionosphere can be derived from (*a*) radio sounding, a method of direct exploration now being conducted by upwards of forty stations all over the world, (*b*) changes in the geomagnetic field, and (*c*) auroral manifestations. Soon it should also be possible to use rockets. The general structure of the ionosphere, with its *D*-, *E*- and *F*-layers, has been known for some twenty years. The ionization densities of the *E* and *F* layers have been measured at Slough since 1931, and it is known that there is a considerable

sunspot cycle variation. Since 1935 Mr. Piggott and he studied D layer ionization indirectly by measuring absorption. A similar sunspot cycle variation of about 60 per cent was found, which is the same as the corresponding change in the geomagnetic currents. From this we can conclude that the geomagnetic currents, required by Balfour Stewart's theory, flow in the lower part of the ionosphere.

Although the E and F_1 layers behave regularly and much as one would expect according to simple theory, the F_2-layer is anomalous. Ionization is, for example, greater in winter than in summer, and there is a difference between the northern and southern hemispheres. Pre-war studies by Berkner and Wells, and by Eckersley, sought to explain these anomalies. But the extended observations now available render earlier work suspect in that a considerable dependence on longitude, or perhaps a magnetic dip, has been identified, as shown in a recent communication in *Nature*. Sir Edward suggested as a tentative theory that the anomalies should be attributed, not to an annual variation of solar radiation, but to variations of the atmosphere with situation and season.

Another anomaly has been found to occur in connexion with radio fadeouts for, whereas McNish found a 60 per cent enhancement of the magnetic diurnal effect, Mr. Piggott and Sir Edward found an increase in D-layer attenuation of a much greater order of magnitude.

Certain outstanding ionospheric problems still remain: for example, (*a*) the physics of the multi-layer formation; (*b*) the explanation of the F_2-layer morphology; (*c*) the identification of the level of the geomagnetic currents; and (*d*) the elucidation of ionospheric storm phenomena.

Mr. A. H. Mumford (General Post Office) spoke about reciprocity in long-distance transmission. Tests made by the G.P.O. in collaboration with the American Telephone and Telegraph Company were intended to discover whether the vertical angles of transmitted and received rays are equal. Vertical angles were measured on transmissions from Rugby received at Holmdel with 'Musa' equipment. In the reverse direction, a pulse transmitter at Deal, N.J., was received at Baldock. A transmitting aerial with a null in the vertical diagram was used, the direction of the null being swept. The time of disappearance of a particular echo then showed the vertical angle at which it had been transmitted. It was found that in undisturbed conditions the angles were stable and equal at both ends to $\pm 1°$ for hours at a time, and a beam width of 3° in the vertical plane could be usefully steered. During disturbed conditions, however, the beam width needed would be widened from 3° to 8°.

Mr. H. L. Kirke (British Broadcasting Corporation) described experiments on lateral deviation on the route from Daventry to New Delhi using a similar sweeping null in the horizontal plane. The variations in direction were within 1°–2° at almost all times. It is thought they would be greater on longer routes such as to Australia or New Zealand. Some progress has also been made on the effects of the ionosphere on medium waves, where it is merely a nuisance to broadcasters. He hoped there would be more study of attenuation on long routes. He also suggested that studies of the influence of the gyromagnetic frequency on interaction in the ionosphere would be well worth while.

Mr. J. W. Cox (Marconi's Wireless Telegraph Co.) described the large amount of routine application of ionosphere knowledge for communications planning and other uses that was carried out during the War by the Interservice Ionospheric Bureau. This was an extension into war-time of the propagation work led by Mr. T. L. Eckersley in the Marconi Company's Research Division, which formed the technical nucleus of the Interservice Ionospheric Bureau. All types of communication problems were dealt with, including a service which gave warnings of the likelihood of ionosphere disturbances. The war-time advances were more in matters of detail than in understanding; and particularly in regard to the F_2-layer, a theory permitting calculation is badly needed by engineers as well as by geophysicists.

Measurements of the variation of the reflexion coefficient of region E_S with frequency showed that it often has a thickness between 50 m. and 500 m., with an average of 150 m.

Measurements of attenuation show a winter anomaly in region D. In summer, the attenuation varies from day to day by perhaps ± 15 per cent, but in winter, though a number of days have low attenuation, there are some which show values all day up to twice as much as are attained in summer. These days have a 27-day recurrence tendency, but are not associated with magnetic disturbance. Apart from the appearance of reflexions from 80 km. height (which may also occur at other times without attenuation) it has not been possible to correlate them with any other phenomenon. There is also no definite correlation between attenuation and magnetic disturbance at Baddow (51° 40′ N., 0° 30′ E.).

Mr. J. S. Hey spoke of the noise associated with solar disturbances. This is not measurable at wave-lengths less than 1 metre, but above 1½ metres it increases rapidly with wave-length and at 5 metres it is about 10^6 times that which would be expected as thermal noise from the sun radiating as a black body at 6,000° K. With receiving aerials giving a power gain of 100 at 5 metres, the noise is 10^4 times the thermal noise in the receiver. On waves longer than 15 m. the noise drops off, presumably because the longer waves cannot penetrate the ionosphere.

Scatter bursts at heights around 95 km. have been investigated with directional aerials on about 60 Mc./s. It has been found possible to correlate some of them with visible meteors. Experiments in which three widely spaced equipments were directed at the same patch of sky at 100 km. height showed little correlation between reception at the three places. The diurnal curve of frequency of occurrence of bursts is quite definite at each place and is found to depend on the direction of observation. This is taken as further evidence that the bursts are caused by meteors, as there is a diurnal variation in the predominant azimuth of meteors, and it is to be expected that the reflecting power of a meteor train will depend on direction.

Prof. H. S. W. Massey spoke of fundamental processes of recombination and attachment in the ionosphere. The main difficulty is lack of precise knowledge of the absorption of ultra-violet light in oxygen, nitrogen and possibly sodium. It is also necessary to remember that the region of maximum ion production may not be the region of maximum density. The distribution of the various gases is also not known, but it is fairly certain that there will be enough atomic oxygen above 100 km. to absorb all ultra-violet radiation with energy greater than 13·5 volts. This may account for the F_1-layer, but the E- and D-layers must be produced by some-

thing else. The ionization potential of O_2 is 12·5 volts, but its absorption is difficult to calculate and experiments suggest that it is not strong.

The difficulty with regard to the loss of electrons is to account for the observed high recombination rate of 10^{-8}. The reaction

$$O^+ + e \rightarrow O' + h\nu$$

would give a rate of 10^{-12}.

A possibility is

$$O + e \rightarrow O^- + h\nu,$$

which could be fast as there is so much atomic oxygen present. It would need

$$O^- + O^+ \rightarrow O' + O''$$

to give the final equilibrium, and to get the correct recombination-rate would need a high probability of at least 10^{-6} for this reaction, whereas it can scarcely be above 10^{-7}.

Thus only

$$O_2^+ + e \rightarrow O' + O''$$

is left, and it is difficult to be precise about this as the details will also involve the behaviour of molecular nitrogen. It is therefore not yet possible to come to any very definite conclusions, and further advance needs both the computation of theoretical rates, and also improvement in the very difficult experimental technique of measurement.

Sir Edward Appleton, summing up, said that the discussion showed that in spite of the War, and even because of it, it had been possible to make notable scientific progress. Prof. Chapman, from the chair, commented that most of the war-time material remained difficult of access, and he hoped it would be published in as much detail as possible. He instanced the detailed publications of meteorological stations in which the availability of a large amount of information had often proved quite unexpectedly useful, and hoped that some similar publication could be made of ionospheric information. J. W. Cox

NEWS and VIEWS

Mechanical Engineering at the Imperial College: Prof. C. H. Lander, C.B.E.

PROF. C. H. LANDER, who is retiring from the chair of mechanical engineering at the City and Guilds Engineering College, University of London, has played an outstanding part for a long period in research and education in engineering, particularly in relation to the utilization of fuel. He obtained varied practical experience in engineering over several years, first with the Manchester Ship Canal Company, then as assistant to Mr. Charles Hopkinson and later with Heenan and Froude, Ltd. As a result he had acquired an excellent background before taking the course in engineering at the University of Manchester, where he graduated in 1905 with first-class honours and was awarded the Fairbairn Prize. He was demonstrator and later lecturer in engineering in the University of Manchester during 1906–16, in which year he was awarded the degree of D.Sc. for a series of original investigations on heat flow, surface friction, and allied subjects. During this period he was also part-time engineer to the Home Office in charge of experimental work on heating and ventilation; this work was the basis of provisions in the Factory Acts. During the First World War Dr. Lander served as an officer in the R.N.V.R., and his important service was recognized by one of the awards to inventors for secret war inventions.

Soon after the establishment of the fuel research organisation of the Department of Scientific and Industrial Research, Dr. Lander was appointed assistant to the Director of Fuel Research (the late Sir George Beilby), and he was rapidly promoted to deputy director in 1922 and director in 1923. In 1928 he was awarded the C.B.E. It was in 1931 that he returned to academic life as professor of mechanical engineering at the City and Guilds College, where he has advanced education not only in mechanical but also in chemical engineering, and has inspired post-graduate research. Prof. Lander's ability and experience were invaluable during the Second World War. He played a prominent part in the development of flame-throwers, gas turbines and jet propulsion, and petrol burners (F.I.D.O.) for dispersion of fog over airfields. For many years he was vice-chairman of the British National Committee of the World Power Conference, to mention only one of the many organisations assisted by his knowledge and advice. Perhaps the work in which he has been most interested is that in relation to heat transfer, on which he has led teams of investigators for more than twenty-five years. Though he has reached retiring age, Prof. Lander will not be idle. He is president-elect of the Institute of Fuel; a year ago this Institute awarded him the Melchett Medal for his distinguished work.

Dr. O. A. Saunders

DR. O. A. SAUNDERS, who has just been appointed to the University of London chair of mechanical engineering at the Imperial College of Science and Technology, is a graduate of London and Cambridge and was a senior scholar at Trinity College, Cambridge, during 1926–29. After leaving the University he was trained at the Fuel Research Station under Dr. C. H. Lander and Eng.-Capt. J. Fraser Shaw, after which he specialized on the thermodynamical side of fuel and power appliances. His work on industrial heat transmission is well known, and in 1921 he published in collaboration with Dr. Fishenden a standard book on heat transmission. In 1932 he took up the post of lecturer in applied mathematical physics in the Mechanical Engineering Department at Imperial College, and in 1937 became the first Clothworkers' reader in applied thermodynamics. During the War his services were seconded to the Ministry of Aircraft Production for special investigations on internal combustion engines, and later he joined the Directorate of Turbine Engine Research, in which he was in charge of research on jet propulsion and gas turbines.

Dr. Saunders has published numerous original papers including fundamental investigations of heat transfer by convection in gases and liquids, radiation and the phenomenon of exhaust gas discharge from

internal combustion engines, and also various papers in engineering journals. He has contributed considerably to the science of heat transmission and the flow of gases, and to the theory of the internal combustion engine applied to modern developments. His interests lie both in fundamental thermodynamics and fluid mechanics, and in applications of the gas turbine prime mover to the propulsion of aircraft, ships and for the generation of power on land. He is chairman of the Turbines, Jets and Rockets Sub-Committee of the Aeronautical Research Council, chairman of the Mechanical Engineering Panel of the Ministry of Aircraft Production Gas Turbine Collaboration Committee and chairman of the Submarine Propulsion Sub-Committee of the Admiralty Scientific Advisory Panel.

Sir John Lennard-Jones, K.B.E., F.R.S.

Although he has held the Plummer chair of theoretical chemistry in the University of Cambridge for fourteen years, only for about one half of that time has Sir John Lennard-Jones been the academic man pure and simple. Since early in the War he has been a Government servant; and his resignation from the post of Director General of Scientific Research (Defence) has just been announced. Sir John first left his university post, to which he is now returning, in 1939, when he joined the Ministry of Supply to take charge of a group of scientific workers. Later, as chief superintendent of armament research, he controlled research being done for all three Fighting Services. His wide experience in the armaments field goes back to the First World War, when he left the R.F.C. as a flying officer to work at the Experimental Station at Orfordness. Latterly, as Director-General of Defence Research, he was in charge of a dozen stations scattered the length and breadth of Britain. Although he is now going back to Cambridge, Sir John will still be connected with the Ministry of Supply, the University having agreed to make his services available on a part-time basis as chief scientific adviser.

Physics at Reading: Prof. R. W. Ditchburn

Prof. R. W. Ditchburn, who has been appointed to succeed Prof. J. A. Crowther in the chair of physics in the University of Reading (see *Nature* of March 30, p. 401), graduated at Liverpool. In 1922 he went to Cambridge, where he worked under Sir J. J. Thomson in the Cavendish Laboratory on the continuous absorption of light in potassium vapour. He held the Isaac Newton studentship during 1925–28. In 1928 he was elected fellow of Trinity College, Dublin, and in the following year became Erasmus Smith's professor of natural and experimental philosophy. His researches in Dublin extended his earlier work on the continuous absorption of light in vapours of alkali metals. He also worked on the theory of optical instruments and the properties of thin films. During the War he returned temporarily to England to work for the Admiralty on problems connected with the psycho-physics of vision. Having wide humane interests and a natural capacity for administration, Prof. Ditchburn made opportunity in the midst of an active career as a physicist to shoulder the responsibilities of registrar of the School of Social Studies and to organise a great deal of social work through philanthropic channels. The influx of refugees into Eire during the last ten years much increased the scope of this work. His return to England will be a most opportune accession of administrative and research experience at a time when post-war university re-organisation is just getting under way.

University Grants Committee

In a Parliamentary written reply on July 30, the Chancellor of the Exchequer stated that the University Grants Committee ought to play a more positive part in the expansion and planned development of the universities of Britain, and accordingly it has been given the following new terms of reference:

"To inquire into the financial needs of university education in Great Britain; to advise the Government as to the application of any grants made by Parliament towards meeting them; to collect, examine, and make available information on matters relating to university education at home and abroad; and to assist, in consultation with the universities and other bodies concerned, the preparation and execution of such plans for the development of the universities as may from time to time be required in order to ensure that they are fully adequate to national needs".

Tercentenary of Flamsteed

The tercentenary of the birth of the Rev. John Flamsteed, first Astronomer Royal and rector of Burstow, Surrey, will be commemorated at a special evensong at 3.30 p.m. on Sunday, August 18, in Burstow Church. The present rector, the Rev. A. Hackblock, will conduct the service, after which the Astronomer Royal, Sir H. Spencer Jones, will give an address on Flamsteed's work. Representatives of the Royal Astronomical Society and other bodies will be present. Flamsteed, who was born on August 19, 1646, at Denby near Derby, was made by Charles II "Our Astronomical Observator" in 1675, and Flamsteed House, at the Royal Observatory, Greenwich, was built for his use. His salary was but small and he had to find his own instruments. His enthusiasm and industry, however, enabled him to overcome these and other difficulties, and he laid well and truly the foundation of the fame of the Observatory. In 1684 he had been given the living of Burstow, and at his death in 1719 he was buried in the chancel of the church. In 1887 the late J. J. Tustin erected the east window and a memorial tablet to his memory. The church is situated about three miles south-west of Horley, and the Reigate–Horley–East Grinstead bus, No. 424, gives a half-hourly service to within half a mile of it.

Centenary of John Owens

The *Manchester Guardian* of July 27 contained an appreciation of John Owens, the founder of Owens College, Manchester, now the University of Manchester, who died on July 29, 1846, at the age of fifty-five. Owens had been in business with his father as a furrier and a maker of hat linings, but had afterwards engaged in other business enterprises, and, being a bachelor of simple tastes and abstemious habits, had accumulated a considerable fortune which it is said he wished to leave to his closest friend, George Faulkner. But of the money Faulkner would have none; he prevailed upon Owens to make a will leaving his fortune for educational purposes. An institution was to be set up at or near Manchester for the instruction of young persons in such branches

of learning and science as "are now or may be hereafter taught in the English universities", but subject to "the fundamental and immitable rule and condition" that the professors, officers, students, etc., shall not be required to submit to any religious test whatsoever. Owens's estate realized £168,025 10*s*. 5*d*., and the residue which came to the College was £96,654 4*s*. 6*d*. The College was opened in 1851 in William Cobden's old house, and new buildings were erected in 1870–73. Frankland was the first professor of chemistry, and in 1857 he was succeeded by Roscoe, under whom worked many men afterwards famous. The engineering department was opened in 1868 with Osborne Reynolds as professor of civil and mechanical engineering. "Owens," says Mr. Redford, in the article referred to, "was a plain man with no aspirations to greatness, who builded better than he knew."

Memorial to John Dalton

Two years ago, on the occasion of the centenary of the death of John Dalton (see *Nature*, 154, 103; 1944), the Society of Friends arranged to erect a memorial stone to his memory in the quiet graveyard at Pardshaw Hall close by his birthplace, Eaglesfield, near Cockermouth, Cumberland. Dalton was educated at the Quaker School at Eaglesfield and was a teacher there before he removed first to Kendal and then in 1793 to Manchester, where he spent the remainder of his life. At his death on July 27, 1844, he was buried in the public cemetery at Ardwick, but it is considered by some that he would have preferred to be buried in his native county. Owing to the War the plan made in 1944 for a memorial stone had to be postponed, but is now to be carried out. The stone will bear his name, places and dates of birth and death, and the epitaph "Not for an age but for all time: This to his memory".

Mineral Development in Great Britain

The Minister of Fuel and Power has appointed a committee, to be known as the Mineral Development Committee, with the following terms of reference: "To inquire into the resources of minerals in the United Kingdom, excepting coal, oil, bedded ironstone, and substances of widespread occurrence; to consider possibilities and means of their co-ordinated, orderly, and economic development in the national interest, and to make recommendations in regard thereto".

The Committee is constituted as follows: Lord Westwood (Chairman); Mr. T. Balogh (Institute of Statistics, University of Oxford); Mr. A. R. Davies (partner in the firm of T. C. Horabin and Partners, industrial consultants); Prof. W. R. Jones (Imperial College of Science and Technology; adviser to Board of Trade (China Clay); chairman, China Clay Working Party); Mr. L. C. Hill (technical adviser to the board of directors of Rio Tinto, Ltd.); Prof. A. O. Rankine (chief physicist, Anglo-Iranian Oil Co., Ltd.); Prof. J. A. S. Ritson (professor of mining, Royal School of Mines; deputy chairman of the Coal Commission); Mr. Stanley Robson (director of Imperial Smelting Corporation, Ltd.); Mr. Tom Steele, M.P.; Captain Peter Thorneycroft, M.P.; and Mr. R. E. Yeabsley (partner in the firm of Hill, Vellacott & Co., chartered accountants). The secretary of the Committee is Mr. W. C. C. Rose, to whom all communications should be addressed at the Ministry of Fuel and Power, 40 Upper Brook Street, London, W.1.

Scientific Posts in the Development of Atomic Energy

According to the *Daily Mail* of August 3, Mr. L. J. F. Brimble, joint editor of *Nature*, attacked "Secrecy over the appointment of scientists to posts in the development of atomic energy", at a gathering of "scientists at Wadham College, Oxford". This statement is so inaccurate as to convey the opposite of that which Mr. Brimble actually did say. He was addressing the summer school of the British Social Hygiene Council on "Science and Social Progress". In dealing with atomic energy, Mr. Brimble pleaded that public (especially lay) opinion should be based on more accurate and fuller knowledge. He gave a brief history of atomic research in an attempt to show that no one country could claim all the credit, and emphasized the important pioneer work of Dalton in Manchester followed later by the crucial researches under Rutherford at Cambridge. This, he claimed, should be more widely known, for it might surprise some if they knew how widespread among the lay public was the belief that all atomic research had so far been practically confined to the United States. As regards the appointment of physicists to posts dealing with atomic research, Mr. Brimble neither said nor implied anything. In fact it should here be stated that in the opinion of the Editors of *Nature*, such posts as exist in Britain are held by the most suitable and competent men of science, and, so far as they are aware, there has been no "secrecy" in appointing them. Mr. Brimble did, however, direct attention to the hasty decisions being made in appointing personnel to certain scientific and educational bodies—decisions which seem to be made by a few without consulting other authorities—and often not followed by any published announcement of such appointments. Those bodies which Mr. Brimble had in mind are far removed from atomic energy, or indeed any other kind of scientific research.

Pharmaceutical Products and their Manufacture

Mr. B. A. Bull, in his address as chairman to the British Pharmaceutical Conference meeting in London on July 16, reviewed the various fields of development in pharmaceutical practice which have occurred during the past ten or fifteen years. A good deal of attention has been devoted to methods of analytical control, particularly the extension of physical methods, such as spectroscopic, adsorption, fluorimetric, X-ray and the selenium cell. The technique of microanalysis had been developed so that routine examinations can be carried through with a considerable degree of both speed and accuracy. Adsorption has been applied in the development of chromatography. The range of synthetic chemical compounds having medicinal properties has been widely extended and, in addition to the synthesis of naturally occurring substances such as the vitamins and the development of fermentation, and biological processes, whole series of new compounds possessing marked physiological activity have been prepared. The search for true chemotherapeutic agents has proceeded with increased vigour and with considerable success, notably in the case of penicillin.

Many new developments have occurred in the basic processes underlying manufacturing processes. Thus with vacuum evaporators, the design has tended to emphasize the advantage of rapid circulation of the liquid with a consequent diminution in

the risk of damaging the product due to local overheating. Electronics have brought a contribution in the evaporation of solutions of heat-sensitive materials such as penicillin by means of radio-frequency dielectric heating, in which the heat is generated directly in the liquid concerned. No temperature gradients are present as is the case when an external source of heat is used and heat transfer has to take place through the wall of the container. Radio-frequency heating is not an economic proposition for heating stable liquids, but may prevent serious losses of activity in heat-sensitive ones. Considerable progress had been made in drying; and spray-drying, flash-drying and drum-drying have been developed with considerable success. The so-called freeze-drying has proved extremely valuable in the final stages of drying penicillin. Much attention has been given to the materials used for the construction of plant and storage vessels. Stainless steel has proved extremely useful, but experience has discovered some important defects in its characteristics which require careful attention; thus when it is welded, seeping may develop through the metal on a line parallel to the weld. Research has shown that if stainless steel is kept for a short time at a temperature of about 650° C., changes in crystalline structure take place which render the material susceptible to cracking on the application of even slight mechanical stress and to corrosion by liquids which will not attack normal stainless steel. Great care must therefore be taken that it is not subjected to conditions which will take from it the right still to be regarded as stainless steel.

Institution of Electrical Engineers

THE May issue of the *Journal of the Institution of Electrical Engineers* contains a foreword with the heading "Seventy-Five Years", describing the manner in which the eight founder members of the Institution met in May 1871, "To consider the expediency of forming a Society of Telegraph Engineers, having for its object the general advancement of electrical and telegraphic science and more particularly for facilitating the exchange of information and ideas among its members". At the outset the Society devoted most of its attention to electrical telegraphy, but in 1879 its scope was enlarged and its title changed to "The Society of Telegraph Engineers and Electricians", in order to provide for the interest aroused by the commercial application of electric lighting. With the rapid development of electrical engineering the title was altered again, to "The Institution of Electrical Engineers", in January 1889, when Sir William Thomson, later Lord Kelvin, delivered the first presidential address to the new body, which was granted a royal charter of incorporation in 1921. During the seventy-five years of its existence, the Institution has become an important and influential body with nearly 13,500 corporate members and more than 15,000 members of other grades on its register. With the aid of the specialized sections formed in recent years to deal with the fields of installations, measurements, radio and transmission, the Institution caters for this vast membership by pursuing a steady, but vigorous, policy of promoting the general advancement of electrical science and engineering and their applications.

The following have been elected officers of the Institution of Electrical Engineers for 1946–47: *President:* V. Z. de Ferranti; *Vice-Presidents:* J. Hacking, T. Graeme N. Haldane, Prof. E. B. Moullin; *Honorary Treasurer:* E. Leete; *New Members of Council:* Dr. T. E. Allibone, D. B. Hoseason, Col. B. H. Leeson, H. Nimmo (members); C. S. Briggs, Dr. F. C. Williams (associate members); G. Wansbrough (companion).

Joints and Sealing Ends for Pressure Cable

A PAPER by Dr. L. G. Brazier, read in London before the Institution of Electrical Engineers, discusses the general principles involved in the design of joints and sealing ends for pressure-cable installations. Design standards based on experimental results are given, and practical methods of construction are described. An account is also given of the gas-control accessories of a pressure cable, including leak location methods. Special attention is given to the problem of voltage surges in relation to joints and sealing ends, and it is shown that the voltage surges specified as representing service conditions are now a critical factor determining the amount of insulation. The relative economics of providing for the voltage surges by additional insulation or alternatively by surge diverters are examined.

A Scottish Statistical Research Bureau

A SCOTTISH STATISTICAL RESEARCH BUREAU has been set up in Edinburgh, following discussions which have taken place between the four Scottish universities and the Faculty of Actuaries. Its object is to place statistical experience and advice at the disposal of research workers in possession of statistical material. The Bureau functions through a Central Committee, of which the first chairman is Mr. J. G. Kyd, Registrar-General for Scotland and lately president of the Faculty of Actuaries. The secretary is Mr. E. Waugh, Faculty of Actuaries, 23 St. Andrew Square, Edinburgh.

Prehistory in South Africa

THE first number of a new series of bulletins of the South African Archæological Society, Cape Town, will be of general interest to all prehistorians. These bulletins will not be confined exclusively to South African studies, but will embrace accounts of research done in other areas. The first bulletin, for example, not only describes a preliminary survey of work in South Africa and discusses colour in prehistoric rock paintings, but also includes an account by J. d'A. Waechter of an archæological excavation in the Middle East, and a brief note on the mesolithic cultures of Britain. These bulletins will help to link up more closely South African archæologists, and also act as a convenient medium between them and their colleagues in other countries.

A Blue Moon

Sky and Telescope for March has an article by J. Hugh Pruett with the title "Once in a Blue Moon", in which there is a discussion of the origin of the expression. The chief interest in the article consists, not so much in referring to the theories regarding the origin of 'a blue moon', as in providing irrefutable evidence from several sources that a blue moon has actually been observed on different occasions. The author of the article states that he saw the phenomenon himself on July 28, 1944. The moon was at the first-quarter phase that day and was thinly veiled by a small patch of high cirrus clouds which were tinted a beautiful orange-red by the sun just below the horizon. It was thought that the lunar blue might be the effect of contrast with the red of the clouds, but this view was shown to be incorrect

because the moon soon floated out into a clear sky, and was just as blue as ever. Others with Mr. Pruett witnessed the phenomenon, which persisted for 15 minutes but gradually disappeared as the sky darkened. Many others have witnessed a similar occurrence at different times and no explanation is offered for the phenomenon, which is not, of course, astronomical but meteorological, and possibly partly psychological.

Bulletin of the Atomic Scientists

THE *Bulletin of the Atomic Scientists*, issued by the Atomic Scientists of Chicago, Inc., is now on sale at a subscription of two dollars a year or one dollar for six months. Single copies, issued twice a month, are 10 cents each. From No. 8 (for April 1, 1946), the *Bulletin* has had sixteen pages or more per issue. The issue for April 1 reprints in condensed form the American State Department Committee's report on the control of atomic energy, together with a draft convention on atomic energy, and an article by Prof. P. M. S. Blackett on atomic energy and the Atomic Energy Committee of the United Nations Organisation. The State Department's report is further discussed in the next issue, which also includes an article on medical and industrial uses of fission-pile products, and the text of the revised McMahon Bill for the control of atomic energy. Articles on "Physics and Politics" by C. E. Merriam, "Science and International Co-operation" by E. U. Condon, "Science and National Policy" by L. A. Du Bridge, and on Hiroshima, are features of succeeding numbers.

Old Scientific and Medical Books

CATALOGUES have recently been issued by E. Weil, of 28 Litchfield Way, London, N.W.11 (No. 8, Alchemy, Chemistry and Psychology); and Herbert Reichner, 34 East 62nd St., New York, 21 (Literature, History, Art, Law and Science). The former lists some three hundred works, many of which are of importance in the history of science, and some of great rarity. Among them may be mentioned works by Tycho Brahe; Robert Boyle, including one bearing an inscription suggesting former ownership by Robert Hooke; and a number of original editions of the writings of S. Freud. Other outstanding items are copies of William Withering's "An Account of the Foxglove, and some of its Medical Uses"; a fine copy of an early edition of the "Margarita Philosophica" of Gregorius Reisch; and an almost perfect copy of Elias Ashmole's "Theatrum Chemicum Britannicum".

Herbert Reichner includes, among the 213 books offered for sale, works of scientific interest on alchemy, chemistry, physics, botany, geology, geography, medicine, and related subjects. Among the more important works listed are a number by or referring to Isaac Newton, with two of his chemical MSS.; a complete set of Dalton's "New System of Chemical Philosophy", all first editions, bearing presentation inscriptions from the author to Sir John Hawkshaw; and also a set of the original editions of Benjamin Franklin's "Experiments and Observations on Electricity", "Supplemental Experiments" and "New Experiments". Geology is represented by, among other items, a copy of the "De Montium Origine" of Valerio Faenzi, published in Venice in 1561, an extremely rare work, to which attention was recently directed by the late Prof. F. D. Adams, in his "Birth and Development of the Geological Sciences"; and by a little-known eighteenth-century systematic treatise on geology, J. S. Schröter's "Vollständige Einleitung in die Kenntniss und Geschichte der Steine und Versteinerungen".

Both catalogues are, as is usual with these two booksellers, extensively annotated; and that of Herbert Reichner contains a lengthy and valuable list of works of reference used in compiling the catalogue, a number of which are offered for sale.

Colonial Service Appointments

THE following appointments have been announced by the Colonial Office: D. W. Goodall, to be plant physiologist, West African Cocoa Research Institution, Gold Coast; G. J. Leggat, to be assistant conservator of forests, Uganda; Capt. A. E. Dorman, to be veterinary officer, Kenya; R. Miller, to be agricultural superintendent, Nigeria; Capt. S. Stock, to be geologist, Somaliland; Major P. E. Williams, to be pasture management officer, Department of Science and Agriculture, Jamaica; S. Gillet, senior agricultural officer, and experimentalist, Kenya, to be senior coffee officer, Kenya; L. P. Henderson, senior agricultural officer, Nigeria, to be principal agricultural officer, Nigeria; G. W. Lines, senior agricultural officer, Sierra Leone, to be principal agricultural officer, Sierra Leone; A. E. Moss, agricultural officer, Gold Coast, to be senior agricultural officer, Gold Coast; B. E. V. Parham, agricultural officer, Fiji, to be senior agricultural officer, Fiji; T. A. Strong, conservator of forests, Ceylon, to be director of forests, Malaya; T. Hirst, deputy director of geological surveys, Gold Coast, to be director of geological surveys, Gold Coast; A. Huddleston, geologist, Gold Coast, to be geologist, Kenya; H. A. Hay Barclay, veterinary officer, Nigeria, to be senior veterinary officer, Nigeria; J. H. B. Best, senior veterinary officer, Nigeria, to be assistant director of veterinary services, Nigeria; N. Clarke, senior veterinary officer, Nigeria, to be assistant director of veterinary services, Nigeria; R. Coulthard, senior veterinary officer, Nigeria, to be assistant director of veterinary services, Nigeria; S. G. Wilson, veterinary officer, Nyasaland, to be senior veterinary research officer, Nigeria.

Announcements

PROF. D. R. HARTREE, professor of theoretical physics in the University of Manchester, has been appointed John Humphrey Plummer professor of mathematical physics in the University of Cambridge. The chair has been vacant since the death of Sir Ralph Fowler in 1944.

IN recognition of his studies upon chemotherapy in tuberculosis the College of Physicians of Philadelphia has awarded the Alvarenga Prize for this year to Dr. William H. Feldman, of the Mayo Foundation for Medical Education and Research.

THE Medical Research Council has made arrangements with the Medical School of King's College Hospital, London, for the establishment of a Dental Research Unit there under the direction of Dr. J. D. King, of its scientific staff.

MR. FRANK TWYMAN has resigned his position as managing director of Adam Hilger, Ltd., which he has held since 1902, to become technical adviser to the firm and to their associates, E. R. Watts and Son, Ltd. Mr. Twyman remains chairman of Hilger's. His place as managing director is taken by Mr. G. A. Whipple, who is also managing director of Watts; he is the son of Robert S. Whipple, chairman of the Cambridge Instrument Company.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Solar and Sidereal Diurnal Variations of Cosmic Rays

THE study of the solar diurnal variations of cosmic rays, which has been described elsewhere[1], has now been extended, in respect of the first harmonic, by arranging in six groups the data for 860 complete days during the period May 1941–April 1944. The first group consists of the data for January and February of all three years, the second group of data for March and April of all three years, and so on, the material for each day consisting of 12 bi-hourly numbers of triple coincidences.

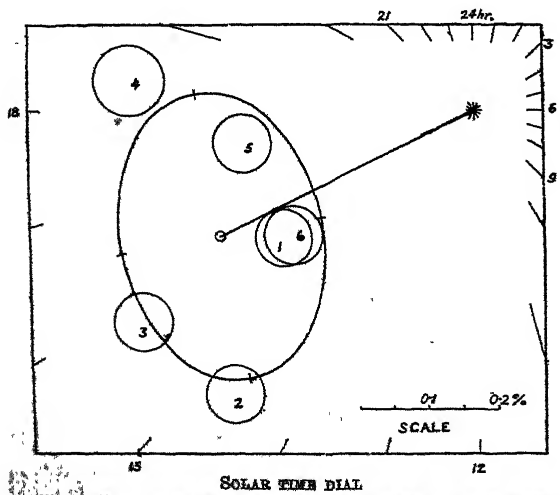
The second and third columns of the accompanying table give respectively the average amplitude in percentage of the mean intensity and time of maximum of the apparent 24-hour wave in cosmic rays for each of the six groups, and the mean after correcting for non-cyclic variation and pressure.

As our observations have shown that the daily mean numbers of particles after correcting for air-mass absorption are generally well correlated with the heights of the 75 mm. pressure-level, it was necessary to ascertain whether the daily change of temperature had any appreciable effect on the height of that layer, so affecting the apparent diurnal variation of cosmic rays. For this the upper-air data obtained in England during the period November 1943–October 1945 by sending up sounding balloons every six hours have been used. Monthly averages of the departure from daily mean height for each hour have been correlated with similar departures of ground temperature, and it has been found that the correlation coefficient, by using 48 pairs of departures, has the very high value of 0·92. For the regression coefficient, we obtained, contrary to what had been generally supposed, the quite appreciable value of 18 metres per degree C., about 0·4 times the seasonal change. There can be no doubt that such a correlation is chiefly due to the heating of the stratosphere by radiation, the difference between the average temperatures at noon and midnight being about 3° C. at 16 km., in contrast with a corresponding difference of only 1° C. or rather less at 7 km. It is therefore to be expected that at levels a few kilometres higher than 16 km. the effect of daily change of ground temperature will be even more appreciable.

As the mean rate of decay of mesons previously found is 0·0054 per cent per metre, a temperature change of 1° C. during the day would imply a variation in cosmic ray intensity of 0·1 per cent as measured by our apparatus. By correcting for this effect we have the values given in the last two columns of the following table:

Group	Ampl.	$t_{max.}$	Ampl.	$t_{max.}$
1 (Jan.–Feb.)	0·23%	16·3h.	(0·33 ± 0·04)%	15·7h.
2 (Mar.–Apl.)	0·26	14·9	0·54 ± 0·04	14·7
3 (May–June)	0·30	17·7	0·59 ± 0·04	15·8
4 (July–Aug.)	0·45	20·7	0·50 ± 0·05	18·3
5 (Sept.–Oct.)	0·28	20·4	0·34 ± 0·04	17·5
6 (Nov.–Dec.)	0·22	16·5	0·32 ± 0·04	15·7
Mean	0 244	18·1	0·414 ± 0·018	16·3

Ignoring the very small possibility of an effect due to thunderstorms, we conclude that the seasonal change in time of maximum as well as in amplitude shown by the last two columns of the table could be taken as evidence of the existence of a variation with sidereal time. Thompson[2] has shown that if a sidereal variation is present, alone or together with a seasonal change in the solar amplitude only, a shift



SOLAR TIME DIAL

The radius of each large circle represents the probable error.

in phase is always introduced, and the points representing the apparent solar variation when plotted and taken in chronological order will always have a cyclic arrangement. The harmonic dial of the accompanying figure, in which points representing the values given in the last two columns of the table have been plotted, clearly shows the cyclic arrangement. The existence of a sidereal variation is therefore proved under the hypothesis that the seasonal change in the real solar variation affects only the amplitude, not the phase. In our ignorance of the nature of the agent responsible for the solar variation, it is obvious that this hypothesis is entirely arbitrary, but it appears to be the only means of separating a sidereal variation from a solar one from data obtained at one station only.

On the basis of this hypothesis we obtain for the sidereal variation an amplitude of 0·21 per cent, with the maximum at about 21 hours sidereal time. This amplitude is of the same order of magnitude as that predicted originally by Compton and Getting[3] assuming the extra-galactic origin for the rays.

As for the solar amplitude, it is found that the minimum occurs probably in December and the maximum in June, with the values of 0·06 and 0·77 per cent respectively. Such a seasonal change suggests that the solar variation is closely controlled by the sun, though it is difficult to see through what agency the sun exerts its influence. However, the fact that the ratio of the amplitudes for June and December, $0·77/0·06 = 13$, has roughly the same value as the ratio $\cos^2 \theta_J/\cos^2 \theta_d$, where θ is the zenith distance of the sun, seems to indicate that the solar variation might be due to penetrating particles coming from the sun. For if some of the cosmic rays are derived from that origin, we may expect their intensity to vary, taking into account the absorption by the atmosphere, approximately as $\cos^2 \theta$. It is therefore possible that a solar component of cosmic rays exists. The intensity in June at the time of maximum should represent 1·5 per cent of the total cosmic ray intensity as measured by our apparatus. The fact that the maximum is attained at about 4 p.m. might be due to deflecting action by the geomagnetic field.

If the sun emits cosmic rays, there is no reason, of course, why other stars should not do the same. It is noteworthy that the maximum of the sidereal variation appears to take place some hours after the transit across the meridian of the galactic centre, just as the maximum of the solar component occurs after noon; so one might be led to conclude that a part at least of the cosmic radiation originates within the galaxy.

A more detailed account of this investigation will be published elsewhere.

A. DUPERIER

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July 2.

[1] Duperier, *Proc. Phys. Soc.*, **57**, 468 (1945).
[2] Thompson, *Phys. Rev.*, **55**, 11 (1939).
[3] Compton and Getting, *Phys. Rev.*, **47**, 817 (1935). For comparison, see also Vallarta, Graef and Kusaka, *Phys. Rev.*, **55**, 1 (1939).

Infra-Red Recording with the Cathode Ray Oscilloscope

IN a recent communication in these columns, Daly and Sutherland[1] have described a new instrument in which an infra-red spectrum is traced upon a cathode ray screen having a long persistence of glow, so that the spectrum can be measured rapidly, and, effectively, is seen over a definite range continuously.

We also have recently built such a cathode ray tube infra-red spectrometer, but using a somewhat different form of presentation of the spectrum which seems to us more convenient for practical purposes. In many salient features our instrument is analogous to that of Daly and Sutherland. The radiation entering the spectrometer is interrupted at approximately 18 cycles per second, and after emerging is focused upon a Bell Telephone thermistor bolometer having a time constant of about 8 milliseconds. The bolometer, which has a resistance of 2·2 megohms, is arranged in a balanced bridge circuit, the output from which is fed into a resistance-capacity coupled amplifier of high gain tuned to give a flat response between about 5 and 25 cycles per second. The output from this amplifier is amplified further, rectified, and again amplified before being fed to the vertical deflexion plates of a large cathode ray tube with long afterglow. The rotation of the prism is geared to the contact moving on a circular potentiometer slide wire, thus providing a time-base horizontally on the cathode ray screen. The spectrometer so far used employs a 60° prism of rock salt or quartz with about 2½ in. length of refracting face in Wadsworth mounting, the whole being enclosed in a 'Perspex' box; the amplifier includes numerous filters to remove undesirable noise and pick-up.

The essentially new feature of the present instrument is that the output voltage, after half-wave rectification, is smoothed, so that the trace obtained is the smooth emission curve of the source, against which are troughs due to any absorption bands. This form of record is just the same as that obtained in single-beam recording spectrometers, and seems to us to show the absorption bands—particularly the feeble ones—more clearly than the record produced by a succession of half-wave pulses.

Fig. 1 is a photograph of the spectrometer and oscilloscope taken during the tracing of the absorption of 2.2.4 trimethylpentane between 6·5 μ and 9 μ. The trace is formed within a rectangle 8½ in. × 5½ in. in size. Various cams are available by means of which different widths of spectrum can be projected on the screen, and movement from one range to another is obtained by a screw attached to the rotational mechanism. While still retaining the full resolving power of the spectrometer, it is possible to project a spectral width of about 3 μ for a time of traverse of about 15 seconds. We also show a record of the emission of the Nernst glower between 1 μ and 4 μ, with bands of water at 2·7 μ and of a hydrocarbon at 3·3 μ (Fig. 2).

The full details of this instrument, with several suggestions for further improvement, will shortly be described elsewhere.

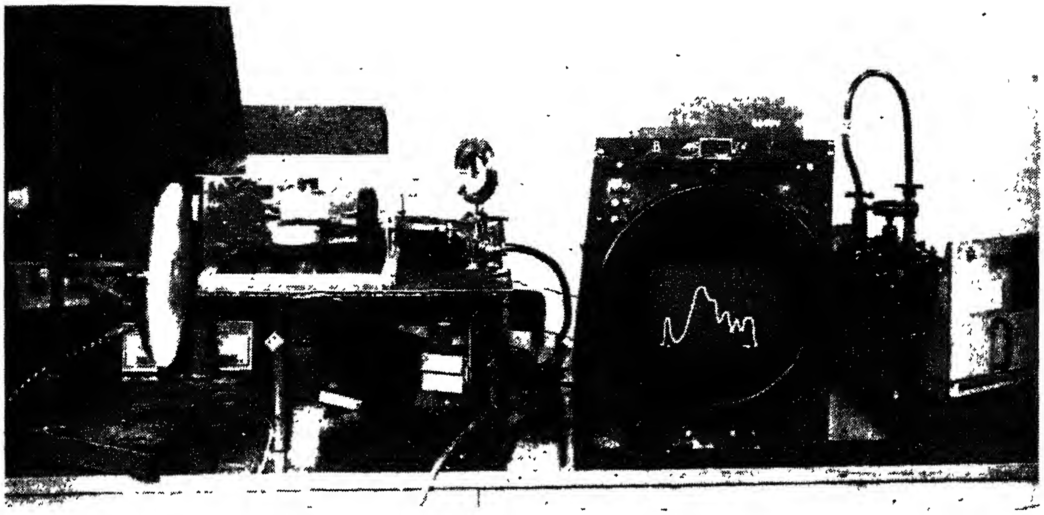

Fig. 1

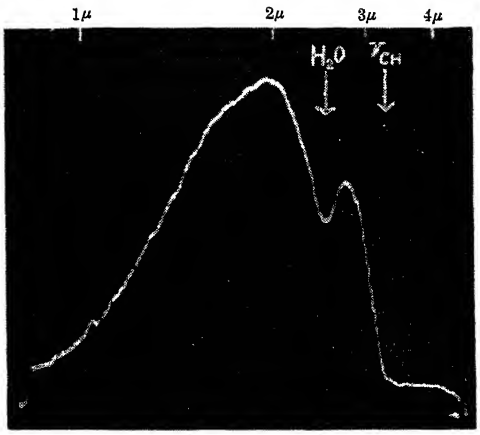

Fig. 2

We are indebted to the Admiralty Signals Establishment for the loan of the thermistor bolometer, and to the R.A.E. Farnborough and T.R.E. Malvern for much electrical equipment. Several other components were obtained with a grant from the Hydrocarbon Research Group of the Institute of Petroleum, to which we are very grateful.

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July 9.

[1] Daly, E. F., and Sutherland, G. B. B. M., *Nature*, 157, 547 (1946).

Radioactivity of Samarium

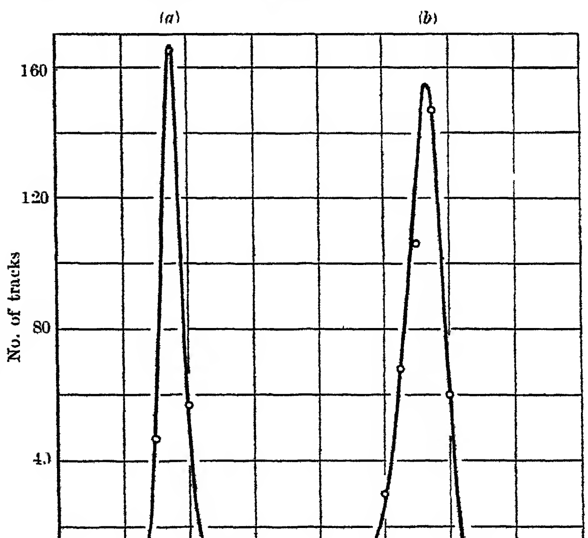
SINCE the discovery of the radioactivity of samarium by Hevesy and Pahl in 1932[1], several experimenters have examined the emitted radiations in detail[2]. It is well established that the main radiation consists of α-particles of range $1 \cdot 13 \pm 0 \cdot 02$ cm., and the experiments of Wilkins and Dempster[3] indicate that these particles are emitted by the isotope of mass 148. In addition, however, a number of experimenters claim to have detected particles of longer range, and present some evidence which suggests that they are protons[4]. Thus Taylor and Dabholkar[5], using the photographic technique, found particles, of longer range than the 1·1 cm. group, continuously distributed in range up to a maximum of 3·5 cm. of air and producing a grain-spacing characteristic of protons.

In view of the very favourable conditions provided by the new Ilford emulsions[6] for experiments of this type, we have made a number of experiments designed to observe the particles of longer range. For this purpose a plate coated with a concentrated emulsion 40 μ thick was used and a solution of 33·75 mgm. of samarium sulphate in 2 c.c. of distilled water was allowed to flow on to it. The water was allowed to evaporate in the course of about two hours in a current of dry air, and after twenty days the plate was washed for an hour and then developed.

The microscopic examination of the plate shows a large number of short tracks which are distributed in length in the way shown in the graph, peak (*a*). In the present experiments the stopping-power of the emulsion relative to air depends on the velocity of the particles. We cannot therefore assume the simple linear relationship between range in air and range in the emulsion which has hitherto been adopted, and which is adequate for the ordinary 'half-tone' emulsion with its much smaller concentration of silver and bromine atoms. Instead we employ a range-energy relation which we have determined from observations on protons and α-particles from d–p and d–α reactions for which the masses are well established. The value thus obtained for the range of samarium α-particles in standard air is $1 \cdot 12 \pm 0 \cdot 03$ cm., in good agreement with previous observations.

In addition to the tracks of short range, we have observed a second group of particles, also homogeneous in energy, which is weak compared with the main group (1·4 per cent) and distributed in length in the way shown in peak (*b*) of the graph. We have found the same group, with nearly the same intensity, in a plate loaded with pure neodymium sulphate, together with a very small number of the short α-particles (5 per cent). It is thus clear that these long-range particles are not due to samarium. By an analogous argument, we can conclude that the long-range group cannot be attributed to neodymium, for the sample of samarium sulphate employed was 99 97 per cent pure.

The discrimination of the first type of emulsion employed was not sufficiently great to allow us to decide whether the long tracks were produced by protons or alpha particles, especially since we have to allow for the possibility of certain change in the grain-spacing of the tracks of a given type of particle due to the presence of samarium. In order to decide this point, we loaded another plate of higher discrimination with a smaller amount of samarium sulphate (3 mgm.), and the visual examination of the long tracks thus obtained indicates that they are to be attributed to α-particles.



The range in standard air, for the long group, is 3 90 ± 0·08 cm. As this range is nearly identical with that of polonium α-particles, we are now making careful tests in order to decide if the second group must be attributed to contamination by this element. It is improbable that the contamination was contained in the sample of rare earth sulphates, for we used material more than ten years old, a period in which the concentration of polonium would have decayed to 1 in 10^8 of its original value. Further, we did not find tracks due to contamination by other radioactive elements, which, in view of their chemical properties, might have been expected in larger amount than polonium.

Because of the integrating characteristic of the photographic plate and the absence of background due to cosmic radiation, or β- and γ-rays, the method gives us a very powerful instrument for determining the decay constant of long-lived radioactive nuclei and of making determinations of very low concentrations of radioactive substances. Thus we have estimated the total number of short-range particles liberated in a given time from a known mass of samarium by counting the number of tracks in specimen areas of the plate and estimating the total area of the emulsion impregnated. As a result, we obtain a value of the decay period of samarium of $(1·3 \pm 0·1) \times 10^{11}$ years. Corresponding to this value of the half-life the concentration of polonium required to give the observed number of long tracks is only 10^{-13} of that of samarium. In the present determination the main error arises from the uncertainty in the precise area impregnated with samarium, and in future experiments this can be substantially reduced by suitable technical improvements.

If the long-range group is not due to contamination by polonium, its presence could be explained by attributing it to the element 61 present in amounts too small to be detected by the usual methods of analysis, and support for such a view can be found in the work of M. Curie and Takvorian[2], who tested the radiation emitted by fractions of samarium and neodymium by electrical methods. They found that the intermediate fractions, which ought to be rich in 61, emitted a more penetrating radiation than pure samarium. The long-range group would then correspond to the disintegration of a nucleus with a much shorter decay period than that of samarium but still long enough to allow us to account for its existence in Nature in small quantities. A serious objection, however, to such an interpretation is that an application of the Gamow theory of the α-decay to this case gives a value for the half-life of the order of only 10^{-7} sec.

In conclusion, we want to thank Dr. C. F. Powell for providing us with the possibility of carrying out this work and also for much helpful advice and criticism. We are indebted to Dr. L. C. Jackson for the pure samarium sulphate and neodymium employed in this experiment, and for pure specimens of six other of the rare earths which we are examining for radioactivity by similar methods.

P. CUER
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The Wills Physical Laboratory,
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July 2.

[1] Hevesy and Pahl, *Nature*, **130**, 846 (1932). Hevesy, Pahl and Hoseman, *Z. Phys.*, **83**, 43 (1933). Curie and Takvorian, *C.R. Acad. Sci., Paris*, **196**, 923 (1933).
[2] Curie and Joliot, *C.R. Acad. Sci., Paris*, **198**, 360 (1934). Ortner and Schintlmeister, *Z. Phys.*, **90**, 698 (1934). Libby, *Phys. Rev.*, **46**, 196 (1934). Hoseman, *Z. Phys.*, **99**, 405 (1936).
[3] Wilkins and Dempster, *Phys. Rev.*, **54**, 315 (1938).
[4] Taylor, *Nature*, **136**, 719 (1935). Mäder, *Z. Phys.*, **88**, 601 (1934).
[5] Taylor and Dabholkar, *Proc. Phys. Soc.*, **43**, 285 (1935).
[6] Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, **23**, 102 (1946).

A Zonally Corrected Electron Lens

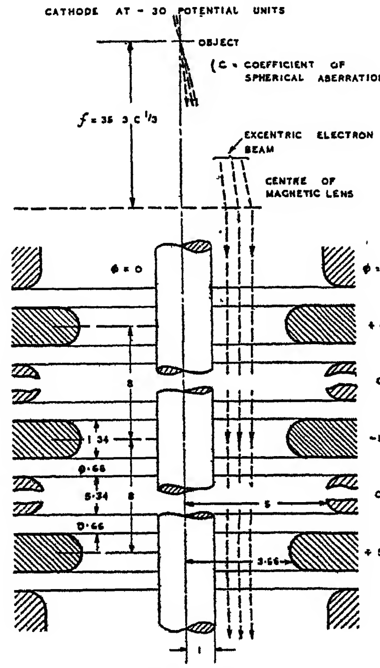
SCHERZER[1] has proved that the first-order spherical aberration of electron lenses can never be corrected by any combination of electric or magnetic fields, in the absence of space charges. Suggestions regarding space charge corrected lenses have been made[2], but have not yet been submitted to experimental tests.

As the present performance of electron microscopes is mainly limited by spherical aberration, it is of considerable interest to explore possible avenues of improvement which are not barred by Scherzer's theorem. Zonal correction, in combination with an annular or excentric stop, is one of these, but it cannot be achieved in electron lenses of the conventional or 'coreless' type, in which the axis is free from electrodes or conductors. Dropping this condition does not, however, lead to as great a variety of new lenses as one might expect, as in the objectives of electron microscopes space is so restricted, and the requirements of accuracy are so high, that only the simplest arrangements can be seriously considered.

In the simplest type, which may be called a 'coaxial lens', there is only one central electrode, consisting of a straight cylindrical wire in the axis, surrounded by one or several annular electrodes. Evidently it is not possible to utilize a complete annular aperture, as the wire must be firmly supported at one or both ends. But it can be easily seen that very little resolving power is lost if the electron beam is restricted tangentially to about the same width as in radial direction. Such beams can be produced by ordinary electron guns, merely by tilting the axis of the gun and of the condenser lens with relation to the axis of the objective, in such a direction as to miss the supports of the central wire. These supports must be arranged in field-free zones, so that the field in the coaxial lens itself is free from perturbations of rotational symmetry.

Preliminary calculations have shown that coaxial lenses cannot be made with sufficiently high power to replace microscope objectives without incurring the danger of auto-electronic discharges. Their use must be rather restricted to the correction of conventional objectives, preferably of the magnetic type. In order to be effective, and to improve the resolving power beyond the present limit, the correcting lens has to fulfil three mathematical conditions simultaneously. In the combination the first, second and third differential quotient of the zonal power with respect to the initial angle of the electron trajectories must be zero, and the fourth as small as possible. In ordinary, coreless lenses the first condition is automatically fulfilled, as the deflexion is in first approximation proportional to the off-axis distance, and thus to the initial angle. But in coaxial lenses the deflexion is in first approximation inversely proportional to the radius; hence even the first condition by itself can be satisfied only by a combination of coaxial lenses, containing one central wire but several annular electrodes.

Lengthy calculations, which could be carried out with the required high accuracy only by means of numerical methods, have shown that these conditions can be satisfied by certain three-element coaxial lenses. An example is illustrated in the accompanying drawing. It may be assumed that the magnetic objective by itself is about as good as possible, with 3 mm. focal length and 0·2 spherical aberration coefficient at 60 keV. In this case the diameter of the central wire must be about 0·27 mm. The other dimensions of the lens are indicated in the figure, with the radius of the wire as unit.



Linear dimensions in units of the radius of the central wire. Potential in units of potential of central electrode

With the potentials as indicated, the aberrations are corrected in a zone of 2 ± 0·135 wire radii, corresponding to an angular range of 0·090 ± 0·006 radian, with an error of not more than 10^{-7} radian. With the above data this gives a geometrical error of about 3 A. and a diffraction error of less than 3 A. This is appreciably less than the optimum values obtainable with uncorrected lenses. It is impossible to say at the moment how this gain will be affected by the unavoidable errors of manufacture. But it may be mentioned that even with a resolving power not superior to that of conventional microscopes, objectives with zonal correction might have a certain advantage, as their focal depth is about thirty times less, which might make it possible to explore objects *in depth*.

The extensive step-by-step numerical calculations which led to the above lens have been carried out by Mr. J. W. Dungey and Miss C. R. Hull, and will be published elsewhere.

I wish to thank the directors of the British Thomson-Houston Company for permission to publish this note.

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Theory of Binary Azeotropes

WE have recently had occasion to survey critically the sparse literature concerned with the theory of azeotropes and have been led to the conclusion that the most general, albeit formally exact, thermodynamic treatment is of little practical use[1,2]. Logical extension of the statistical thermodynamic treatment of strictly regular solutions[3] indicates that azeotropes formed by such solutions would obey the empirical rules of behaviour of real azeotropes which have been advanced by Timmermans, Merriman and Wrewsky. Moreover, we find that closely approximate relations between N_2, P and T (N_2 being the mol fraction of component 2), derivable from the treatment, do in fact describe the behaviour of many of the azeotropic systems which have been experimentally studied.

These relationships are of the following remarkably simple forms.

$$N_2 = \tfrac{1}{2}\left[1 + \frac{H_1 - H_2}{Wab} + \frac{CR}{Wab} T\right] \quad . \quad . \quad . \quad (1)$$

$$\text{Ln}\, P = \frac{A}{RT} + D \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$N_2 \sim A^1 \ln P + C^1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where H_1 and H_2 are the latent heats of vaporization of the pure components 1 and 2 respectively, Wab is the mixing energy, P is the total pressure of the azeotropic system, A, C, D, A^1 and C^1 are constants for a given system which can be identified with other more complex functions of thermodynamic quantities.

It appears that there is a broad class of azeotropes the behaviour of which is described by equations 1–3. It is convenient to describe these as *normal azeotropes*.

A fuller treatment of the subject will be published elsewhere.

We are indebted to Dr. R. P. Linstead, director of the Chemical Research Laboratory, for permission to publish this note.

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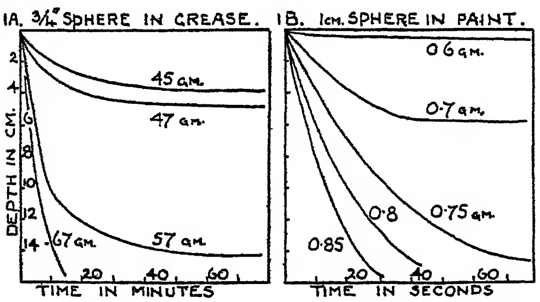
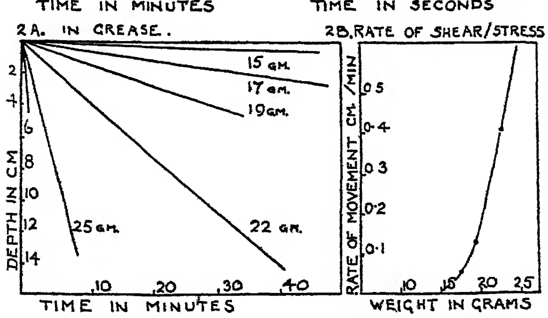
Movement of a Thin Plate in Non-Newtonian Liquids

VISCOSITY (or consistency) results obtained with spheres falling through non-Newtonian liquids, unlike results with Newtonian liquids, appear to be difficult of interpretation mainly because the rate of fall is largely dependent on the depth of the sphere in the liquid. Facsimile tracings on a rotating drum (Fig. 1a) obtained with a ¾-in. diameter steel ball, carrying a fine rigid stem with pen attached, falling through a lime-base grease in a tall beaker approximately 19 cm. high and 9 cm. diameter, indicate that the rate of fall in the upper region of the grease can be many times that in the lower, and it is possible for the ball to remain suspended. Similar results were obtained with paints (100 gm. zinc-chromate in 100 c.c. linseed oil) using a 1-cm. diameter steel ball attached to a fine thread passing over a 'frictionless' pulley and counterpoised by a known weight (Fig. 1b).





The complexity of the fall behaviour is explicable on the assumption that greater energy is required to displace the system at greater depths because of the rigidity of the system.

A thin plate, such as a thin double-edge razor blade or a glass microscope coverslip, should be largely free from this volume displacement difficulty. When the plate was drawn edge on through the grease by means of a fine thread passing over the pulley, with constant counterpoise, the rate of movement through the bulk of the material was practically constant, and by using different weights as counterpoises it is possible to determine the yield value of the grease (Fig. 2).

Measurements of the rate of withdrawal of a plate from pitch using a clearance of 2 mm. from each of the walls were made by Nutting[1]. Dudeski in 1926, working with a larger vessel, determined the apparent viscosity of a sample of asphalt as 10^{11} poises. More recently, Veiler and Rehbinder[2] have measured the resistance of thin plates, 50 μ in thickness, and of total area 15–111 sq. cm. of copper and aluminium foil and mica of rough surface, in clay suspensions. The container with suspension was placed on a falling platform, 3·3 μ/sec., and the pull on the plate measured on a quartz spring to which the plate was attached by a quartz thread: a micrograph scale was used. Veiler and Rehbinder found with the different plates an ultimate shearing stress of 10·60–10·94 dynes/sq. cm. for a clay suspension. Dumanski, using the same method with gelatin solutions, established the invariability of the shear modulus within a broad range of plate areas and for various container dimensions.

Using an immersed rectangular microscope coverslip, 24 mm. by 32 mm., suspended by a fine quartz thread from a glass or quartz fibre beam, fixed at one end, and observing the depression of the free end of the beam (or rise when the movement of the liquid is stopped), when the level of the liquid is allowed to fall by running the liquid out from the bottom of the vessel, it is easy to demonstrate the viscous drag on the plate by a liquid such as water, with a viscosity as low as a centipoise; and to show the drag to be proportional to the rate of flow. With non-Newtonian liquids their peculiar rheological properties can be demonstrated by this method.

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X-Ray Fibre Pattern of Part of a Single Starch Grain: Powder Photographs of Potato, Wheat and Arrowroot (*Maranta*) Starch

ATTEMPTS to elucidate the crystal structure of native starch by means of X-ray diffraction have hitherto failed on account of difficulties due to the small size of the starch grains and their radially arranged crystallites. These circumstances have made it impossible to obtain the so-called fibre pattern of native starch, which is necessary in calculating the net parameters in substances of high polymer nature like this and which has led to a clear picture of the structures of the two related substances, cellulose and chitin.

During recent years we have developed a new micro-method for X-ray diffraction investigation of biological objects[1], which has now enabled us to obtain a fibre pattern of a part of a single starch grain. We used the large starch grains of *Phajus grandifolius*. Before discussing the fibre pattern we will give a description of the powder pattern of *Phajus* starch.

The powder diagram of *Phajus* starch resembles the diagram of potato starch. So we have to do with a *B* pattern, according to the nomenclature introduced by Katz[2] for the various types of starch patterns. In order to compare both diagrams more exactly, we also made diagrams of potato starch. It then appeared that these latter showed a number of reflexions not mentioned by Katz, nor by other authors (references to non-Continental literature were made up to 1940).

By using a narrow X-ray beam and preventing desiccation of the starch during exposure, it became evident, from the diagrams thus obtained, that reflexion 2 of Katz[2,3] splits up into three weak reflexions, 2*a*, 2*b* and 2*c*, corresponding respectively to lattice plane distances of 8·8 A., 7·8 A. and 7·1 A. Reflexion 6*a* of Katz splits up into 6a^1 and 6a^2, corresponding to d = 4·11 A. and d = 4·02 A. Finally, reflexion 8 splits up into 8*a* and 8*b* with d = 2·99 A. and d = 2·86 A. For the lattice plane distance belonging to reflexion 1 we deduced 15·5 A. instead of 15·9 A. as given by Katz. Various other reflexions also showed differences in this respect, but smaller.

Wheat and *Maranta* starch gave powder diagrams showing similar new details, which will be dealt with elsewhere.

Now the powder diagram of *Phajus* starch appeared to differ from that of potato starch only in that reflexions 2*c* and 6a^1 are missing.

In the fibre pattern obtained from the single grain, all reflexions of the powder pattern are found; with the exception of 7 and 8*a*, they show clear maxima, which make it possible to distinguish four layer lines. The direction of the fibre axis is nearly perpendicular to the layers of the starch grain. When calculating the identity period in the direction of the fibre axis from the maxima we find distances varying from 9·2 to 10·3 A., with a mean value of 9·9 A. ± 0·3 A. If we assume straight-chain molecules, parallel to the fibre axis, and assume the period to range over two glucose groups, as is the case in cellulose and chitin, we might expect for this period a distance of *c.* 10·4 A.

It further appears in the fibre pattern that the strong reflexions corresponding to d = 15·5 A. and d = 5·15 A. and a less strong reflexion with d = 4·52 A. (reflexions 1, 4 and 5 of Katz) show maxima at the equator. According to this we can assign these reflexions the indices (001), (003) and (200) respectively. Assuming a primitive orthorhombic cell, this would lead to unit cell dimensions: a = 9·04 A. and c = 15·50 A. in the (0*k*0) plane. We will suppose the period in the *b*-axis to be 10·4 A. as in cellulose and chitin.

Starting from this elementary cell, indexing of all other reflexions appeared to be possible without any difficulty. The differences between calculated and observed values of d generally do not amount to more than 0·5 per cent, except in reflexion 2*a*, where the difference is 2 per cent. Supposing the cell contains eight glucose units and eight molecules of water, the density calculated from this unit cell would be 1·63; omitting the water the density would be 1·47.

The density of starch, as determined with a pycnometer, is given by H. Rodewald[4]. Starch, dried in a stream of hydrogen at 100° C., has a density of 1·49 when determined under chloroform or petroleum ether (1·43 if dried very thoroughly) and a density of 1·60–1·63 when determined under water at 20° C.

Hence there is a remarkable correspondence between X-ray densities and pycnometric densities of dry and wet starch. We should, however, be cautious in using this as an argument for the exactness of the above dimensions of the unit cell. The X-ray density must be related to monocrystals, and if indeed the starch grain were a monocrystal the numbers found might be considered as a proof. The main component of starch, however, is considered to be a network of primary valency chains, which are linked in crystalline micells in which water is bound in the lattice[5]. These micells alone are responsible for the X-ray density found above.

Accepting the correspondence between X-ray density and density of the substance as a whole as a proof of the correctness of the dimensions of the unit cell in the micells, this would include speculative assumptions about the mutual distance of the chains in dry starch, about the differences between the mode of penetration of water on one hand, and of chloroform and petroleum ether on the other, about the mechanism of swelling of wet starch, etc. It would be outside the scope of this communication to discuss these problems here.

Altogether it seems not impossible that the elementary cell of native starch of the *B*-type is a primitive orthorhombic one with the above given dimensions.

We have not yet succeeded in finding an arrangement of primary valency chains and water molecules in the cell that can account for the reflexion intensities and extinctions. In this connexion it is striking that (0*k*0) is absent. Furthermore, it should be noted that the ratio of the axes *a* and *c* is 1 : 1·715. Outlining a hexagonal cell as an orthorhombic one gives nearly the same ratio of axes (1 : 1·73). As the orthorhombic cell found is not centred in the basal plane, hexagonal symmetry, however, must be excluded.

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Photosynthesis, Philosophy and Priestley

THE recent demonstrations, by isotopic analysis[1], that the oxygen evolved during green-plant photosynthesis is derived from decomposition of *water* has falsified what is perhaps the most widespread assumption in text-books. It has been all but universally taught that, because a green plant under the influence of sunlight takes in carbon dioxide and evolves oxygen, the oxygen comes from decomposition of the oxide of carbon. The supposed reaction upon which this teaching is based may be given as

$$CO_2 \rightarrow O_2 + C.$$

The philosophical interest of the persistence of this assumption is twofold: there was no sound evidence for it; and the other vital component in the photosynthetic process is neglected. G. Bredig in 1914[2] was the first to suggest that photosynthetic oxygen came from water, but modern theory has arisen only since 1931[3]. Little opportunity has been afforded for elementary students to learn of the participation of water in photosynthesis.

Absence of evidence is not, of course, a reason for not formulating an assumption. Teaching, however, has gone far beyond presenting the supposed course of photosynthesis as an assumption or hypothesis: the evolution of oxygen by decomposition of carbon dioxide has been repeatedly stated as a fact. In view of the importance of water in metabolism, and in promoting chemical change (including the formation of water itself), it is curious that a role for water in photosynthesis should have been uncritically rejected.

The common lecture-experiment of putting a green plant in water in a stoppered bottle, exposing it to sunlight and testing the evolved oxygen, scarcely leaves room for demonstration of the presence of an equivalent of carbon dioxide: whence does the carbon dioxide come?

Such experiments (as well as general knowledge which should suggest that a 'dry' photosynthetic reaction is inconceivable) denote philosophic blunders for which it is difficult to find parallels. Apart from inattention to the source of the carbon dioxide, the seemingly obvious factor *water* is ignored. Writers of text-books are not infrequently responsible for perpetuation of ancient errors of fact, but it is fair to ask where in modern scientific history can be found a more striking example of preconception smothering facts.

M. W. Beijerinck[4] discussed Joseph Priestley's work among that of microbiological pioneers who had investigated infusions; otherwise it seems to have been overlooked lately that Priestley was much interested by the frequent development of algæ (as we should say now) in extracts of organic matter after they had been exposed to air and sunlight. According to E. I. Rabinowitch[5] an evolution of pure oxygen from algæ on the walls of insolated vessels containing water was called by Priestley "the most extraordinary of all my unexpected discoveries". It seems rather remarkable that the chemical aspect of Priestley's work should have received almost exclusive attention. If more justice had been done to Priestley as biologist, it is possible that teaching about photosynthesis would have been on a more philosophic basis. The indication by Kamen and Barker[1] that atmospheric oxygen is probably of biological origin will enhance appreciation of Priestley's thought.

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Antibacterial Substances in Water Extracts of Pure Forest Litter

IT was reported by Melin[1] that cold water extracts prepared from single species litter of Swedish forest trees contain substances inhibiting the growth of soil fungi. The fungi tested showed, however, pronounced differences in their sensitivity to the antibiotic agents present in the extracts. The species acting as mycorrhizal fungi were the most sensitive ones whereas the species inhabiting litter and causing its decomposition proved to be insensitive. Passage through a Seitz filter does not seem to reduce the antibiotic activity, the growth-inhibiting effects produced by the filtered extracts being approximately equal to those exerted by the corresponding untreated extracts. On autoclaving at a temperature of 120° C. the antibiotic activity of the extracts made from litter of *Acer platanoides* L. and *Fagus sylvatica* L. was increased to a considerable degree. The antibiotic substances present in these extracts had a marked growth-inhibiting effect both on litter-decomposing and mycorrhiza-forming fungi.

In examining litter of a grass species, namely, *Glyceria maxima* (Hartm.) Holmb., for growth-affecting power, Melin[1] found that cold water and hot water extracts of this material had no inhibitory effect on the fungi tested.

In view of the observations summarized above, it seemed of interest to examine whether forest litter extracts contained substances preventing the growth of pathogenic bacteria. Accordingly, cold water extracts were made from pure litter of the following species: *Acer platanoides* L., *Betula verrucosa* Ehrh., *Fagus sylvatica* L., *Fraxinus excelsior* L., *Populus tremula* L., *Quercus robur* L., and *Ulmus glabra* Huds. In addition, an extract of *Glyceria maxima* (Hartm.) Holmb. was investigated.

The extracts tested were prepared as follows.

Air-dried and ground samples of single species litter were thoroughly mixed with distilled water in the proportion 1 : 5 and placed in a cold storage room at 4° C. for 24 hr. In the case of *Glyceria maxima* one part of litter was extracted with six parts of distilled water. After passing through filter paper on a perforated Büchner funnel, each extract was divided into six portions. One portion, denoted by I, was, without further treating, assayed for antibiotic potency. Five portions, indicated by II–VI, were, before testing, treated according to the following scheme: II was saturated with chloroform; III was autoclaved; IV was passed through a Seitz filter; V was autoclaved and passed through a Seitz filter: VI was passed through a Seitz filter and autoclaved.

The autoclaving was carried out for 15 min. at a pressure of 1 kgm. per cm.[2], corresponding to a temperature of 120° C.

The antibiotic power of the litter extracts thus prepared was tested against *Staphylococcus aureus* No. 266 by means of the cylinder plate method as described by Abraham *et al.*[2] but with the modifications detailed by Wikén[3]. After filling the cylinders with the solutions to be assayed, the plates were kept at room temperature for 2 hr. before placing at 37° C.

TABLE 1. RESULTS OBTAINED IN TESTING UNDILUTED EXTRACTS OF SINGLE SPECIES LITTER FOR ANTIBIOTIC ACTIVITY AGAINST *Staphylococcus aureus*

Species	Type of extract					
	I	II	III	IV	V	VI
Acer platanoides	++	++	++	++	++	++
Betula verrucosa	0	0	0	0	0	0
Fagus sylvatica	0	0	0	0	0	0
Fraxinus excelsior	0	0	0	0	0	0
Populus tremula	0	0	0	0	0	0
Quercus robur	0, +	0	+	0	+	+
Ulmus glabra	0	0	0	0	0	0
Glyceria maxima	0	0	0	0	0	0

0, no growth inhibition; +, mean diameter of disks of total growth inhibition ≃ 10 mm.; ++, mean diameter of disks of total growth inhibition ≃ 20 mm.

Some results obtained in assaying the extracts against *Staphylococcus aureus* are listed in Tables 1–3. It is evident that of the litter extracts tested only those of *Acer platanoides* and *Quercus robur* contain antibiotic agents effective against *Staphylococcus* under the conditions of the assay method used. The antibacterial activity of untreated cold water extracts (type I) obtained from various litter samples of *Acer platanoides* is rather high as compared to that of extracts made from litter of *Quercus robur*, the diameters of disks of complete growth-inhibition produced by the former extracts being equal to or greater than 20 mm. and those caused by the latter extracts amounting approximately to 10 mm. Sometimes the quantities of antibiotic substance present in the untreated *Quercus* extracts are not large enough to be detected by means of the cylinder plate method.

TABLE 2. ANTIBIOTIC EFFECTS PRODUCED ON *Staphylococcus aureus* BY UNDILUTED LITTER EXTRACTS OF *Acer platanoides* AND *Quercus robur*

Type of extract	Species	
	Acer platanoides	*Quercus robur*
I	21·1	0
II	22·4	0
III	22·1	10·3
IV	23·6	0
V	22·3	10·8
VI	22·2	10·6

The assay values (mm.) are means of 6 parallels.

The figures given in Tables 2 and 3 show that the antibacterial activity is not destroyed by heating for 15 min. to a temperature of 120° C., the growth-inhibiting properties of the autoclaved extracts (type III), on the contrary, being stronger than those of the corresponding extracts before autoclaving. Furthermore, the substances preventing cell division of *Staphylococcus* are not held back by the Seitz filter, the antibiotic capacity of a filtered extract of *Acer platanoides* (type IV) being even greater than that of the untreated extract serving as a control.

TABLE 3. ANTIBIOTIC ACTION EXERTED ON *Staphylococcus aureus* BY UNDILUTED AND DILUTED LITTER EXTRACTS OF *Acer platanoides*

Type of extract	Dilution				
	Undil.	1 : 1	1 : 2	1 : 3	1 : 4
I	20·0^{6}	18·5^{3}	0^{6}	0^{3}	0^{3}
III	21·8^{6}	21·5^{3}	18·9^{6}	17·0^{3}	12·3^{3}
IV	21·5^{6}	18·9^{3}	16·7^{6}	15·8^{3}	13·3^{3}

In dilution the extracts were mixed with distilled water in the proportions 1 : 1, 1 : 2, etc. The figures placed at the top of the mean assay values (mm.) indicate the number of parallel cylinders used in testing.

The results given in Table 3 may be interpreted as indicating that untreated cold water extracts from litter of *Acer platanoides* contain one or more factors acting as destroying agents upon the antibacterial substances effective against *Staphylococcus*. This being the case, the inactivator or inactivators involved are susceptible to heat and do not pass through a Seitz filter, the extracts III and IV, as noticed above, showing a higher capacity to inhibit bacterial growth than does the corresponding extract I.

The antibacterial substances present in litter extracts of *Acer platanoides* and found to inhibit the growth of *Staphylococcus* diffuse through 'Cellophane' membranes on dialysing against distilled water.

Finally, it may be worth noting that Osborn[4] does not range *Acer platanoides* and *Quercus robur* with the species of green plants found to be active against *Staphylococcus aureus* when tested as extracts from freshly picked material.

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Isolation of the Growth-promoting Factor Present in the Fatty Acids of Summer-Butter

IN 1941 Boer and Jansen showed[1] that summer-butter contains a growth-promoting factor that was neither vitamin A nor one of the other known fat-soluble vitamins. Later, Boer and Jansen demonstrated that the growth-promoting action was due to the saponifiable fraction of the summer-butter. We have now divided the saponifiable fraction by fractional distillation. The different fatty acids obtained in this way were administered to rats, and the growth of the rats on the different fractions was compared. Details of the technique of this test are given in our earlier publications. In a fuller publication, that will appear elsewhere, the method of distillation also will be described.

It appeared that none of the fractions below C_{16} had a growth-promoting action. However, a fraction near C_{18}, containing only vaccenic acid (it seemed to us very improbable that other substances were present in this fraction), had the same growth-promoting action as summer-butter itself.

Vaccenic acid is an isomer of oleic acid ($C_{17}H_{33}COOH$). The double bond, however, is here between C_{11} and C_{12} (in oleic acid between C_9 and C_{10}). The vaccenic acid was identified by its melting point (35° C.), and its iodine-value (81).

TABLE 1. FIRST SERIES. GROWTH DURING 18 DAYS (IN 9TH AND 10TH WEEKS)

Litter	Butter	Rape oil	Rape oil plus vaccenic acid
I	50	20	41
II	36	33	
III	39	37	53
IV	50	34	46
VI	63	35	
VII	45	32	43
	45	32	
VIII	46	34	40
IX	33	33	
X		46	44
XII		34	41
			42
XI		28	38
Mean :	46	32	43

TABLE 2. SECOND SERIES. GROWTH DURING 6TH AND 7TH WEEKS

Litter	Butter	Rape oil	Rape oil plus vaccenic acid
IV	62	13	50
VI	39	35	32
VII	51	39	48
		29	48
IX	47	27	37/36
X	54	48	44
XII	33	34	35
XIV	54	32	34
III	33	23	
XI		44	53
Mean :	47	32	41

In two series of experiments, growth of rats on rape oil appeared to be significantly less than the growth on summer-butter. When the fraction of vaccenic acid was added to the rape oil, the difference in growth between rape oil and summer-butter disappeared completely (Tables 1 and 2). Statistical calculation showed that the difference between rape oil and rape oil plus the vaccenic acid fraction is highly significant.

In our opinion, these experiments show that the growth-promoting action of summer-butter is due to the vaccenic acid. A more detailed description of our experiments will be published elsewhere.

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Liver Glycogen of Alloxan-Diabetic Rats under Different Conditions

IT is generally agreed that a low glycogen level in liver and muscle is a characteristic of pancreatic diabetes. Considerable importance is attached to this phenomenon in the pathology of diabetes. A similar condition has been observed in alloxan-diabetic rats by Lackey, Bunde, Gill and Harris[1].

The present communication reports analyses of the liver and muscle glycogen content of alloxan-diabetic rats under different conditions: in paired feeding experiments, after a 24-hr. fast period, and after fast combined with additional demands on the carbohydrate metabolism (muscular work, phloridzin administration). As diabetic animals have a small appetite, liver and muscle glycogen were also determined in another experimental series following a fast of 24 hr. after prior chronic under-nutrition. The results of these experiments are set forth in the accompanying table.

Treatment	Animals	No. of expts.	Glycogen gm./100 gm. in Liver	Glycogen gm./100 gm. in Muscle	Blood sugar mgm. per cent
Paired feeding	Diabetic	20	1·58±0·21	0·35±0·02	392
	Controls	20	1·50±0·23	0·39±0·02	—
24 hr. fast	Diabetic	34	0·70±0·10	0·23±0·02	299
	Controls	59	0·15±0·04	0·25±0·02	—
48 hr. fast	Diabetic	16	0·18±0·04	0·22±0·03	261
	Controls	13	0·21±0·07	0·24±0·03	—
24–30 hr. fast after under-nutrition	Diabetic	18	1·42±0·20	0·35±0·04	440
	Controls	13	0·69±0·20	0·34±0·03	—
Work expts. Swimming for 1 hr. after 16 hr. fast. Killed (a) before recovery	Diabetic	5	0·08+0·02	0·08±0·02	193
	Controls	4	0·05±0·02	0·11±0·03	—
(b) after 6 hr. recovery period	Diabetic	11	0·59±0·19	0·14±0·02	246
	Controls	11	0·05±0·01	0·14±0·02	—
Administration of phlorizine (2 × 15 mgm.) during an 8–26 hr. fast period	Diabetic	20	0·46±0·09	0·20±0·02	257
	Controls	13	0·06±0·02	0·24±0·03	—

Comatose rats exhibiting marked ketonuria, high blood sugar, high liver fat, deepened breathing, and in general low body temperature were not included in these experiments, as they show an essentially different behaviour. In ten comatose rats the liver glycogen level averaged 0·17 per cent, the average blood sugar being 686 mgm. per cent. After fasting for 24 hr. these rats, in contrast to non-comatose diabetic animals, showed a lower level of liver glycogen than the controls.

The most striking finding is the existence in alloxan-diabetic rats after a 24-hr. fast—alone or accompanied by additional demands on the carbohydrate reserves—of an increase in level of liver glycogen,

despite the continued excretion of sugar in the urine. After a fast of 48 hr., these differences between normal and diabetic animals disappear.

The swimming experiments suggest a possible explanation for this observation. When the animals were killed immediately after swimming, only traces of liver glycogen were found in alloxan-diabetic animals. On the other hand, when the animals were allowed, after swimming, to recover for a few hours, glycogen was found in the liver of alloxan-diabetic animals in abundance, whereas in the controls no rise in the liver glycogen was observed. The obvious explanation of these findings is that the increase in liver glycogen after fasting in alloxan-diabetic rats is due to a stimulation of glycogen-neogenesis, probably in association with the decrease in the utilization of carbohydrates. The experiments show that alloxan-diabetic rats are able to store the newly formed glycogen in their liver. This behaviour recalls the so-called protein effect described by us in an earlier paper[2]. The situation is essentially different in coma, in the sense that although neogenesis of sugar occurs (high blood sugar during fast) storage of glycogen in the liver is no longer possible.

This investigation was aided by a grant of the Dazian Foundation for Medical Research and the Ella Sachs Plotz Foundation.

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Histological Demonstration of Mucin after Periodic Acid

THIS note describes the histological demonstration of mucin by Schiff's reagent following the action of periodic acid. Zenker-formol sections were passed to water, after iodine and hypo, and placed for two minutes in a 0·5 per cent solution of periodic acid in distilled water. The sections were then washed in tap and distilled water and placed in Schiff's reagent for fifteen minutes at room temperature. The customary rinsings in sulphurous acid, as for the Feulgen's test, followed, and the sections were dehydrated in alcohols and mounted in balsam after xylene.

The mucus of the goblet cells of the human intestine and bronchus coloured strongly, as did mucous salivary glands, certain pituitary cells, the colloid of the pituitary stalk and thyroid, granules in some nerve cells in the medulla of the rat and in the human intestine, and the basement membranes of the tubular epithelium and of the glomerulus in the kidney.

The technique is presented as a histological method which appeared during the course of an investigation of the histochemical use of periodic acid. Periodic acid was found by Malaprade[1] to form aldehyde when it split a chain between two carbon atoms each bearing a hydroxyl group, and Nicolet and Shinn[2] found the split occurred also between two carbon atoms if one bore a hydroxyl group and the other an amino group. The new method bears some resemblance to Molisch's test-tube reaction of carbohydrate and mucoproteins, in which an aldehyde is produced by the action of sulphuric acid and gives a colour with α-naphthol. Dempsey and Wislocki[3] say that Schiff's reagent can be used for demonstrating aldehyde derived from mucoprotein after 'mild hydrolysis'.

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Analgesic Properties of Derivatives of Diphenylethylamine

WE were very interested by the reports of Dodds, Lawson and Williams[1] on the analgesic properties of some derivatives of diphenylethylamine. We noticed that, according to those authors, the β-hydroxy compound seems the most promising, although its analgesic power is principally noticeable in the severe pains due to nervous compressions due to cancerous tumours and metastases.

Since 1943 we have been trying clinically the same β-hydroxy compound (the drug was kindly supplied to us by "les Laboratoires Jean Roy"). We also found great analgesic activity on this type of pain. But we obtained successful results with this substance in other hyperalgic conditions, namely, cervical neuritis and trigeminal neuralgia.

Moreover, several cases of painful visceral contractions like enteric occlusion or spastic dysmenorrhœa were completely relieved of symptoms by giving 0·40–0·80 gm. of the drug. Therefore we suggest this compound should be investigated for its possible antispasmodic properties.

We occasionally observed side-effects: nausea or vomiting, with daily doses larger than 1·20 gm. But the absence of 'drug-habit' must be emphasized.

It seems to us that β-hydroxy-α,β, diphenylethylamine (or other derivatives of diphenylethylamine) is worthy of a more extensive clinical assay in the usual therapeutic field of morphine.

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Experimental Infection of the Larvæ of *Anopheles gambiae* (Dipt., Culicidæ) with a *Coelomomyces* Fungus

THE object of this communication is to record the experimental infection of laboratory-hatched larvæ of the malaria-carrying *Anopheles gambiæ* Giles with a fungus of the genus *Cœlomomyces* Keilin after transporting soil and fungal resting sporangia from the infected locality at Livingstone in Northern Rhodesia to Johannesburg (Transvaal), a distance of several hundred miles. The infection of the larvæ was obtained in a concrete trough after the resting sporangia had lain dormant for more than eight months. This note is supplementary to a paper by me published recently[1], and the species of the fungus is that referred to as type *a* in the paper.

It had previously been found that the resting sporangia of another species of *Cœlomomyces*—my type *c*, parasitic in the larvæ of *Aëdes* (*Mucidus*) *scatophagoides* Theo.—would germinate after a longish period of desiccation before being wetted again, the zoospore liberation of which has been described by De Meillon and Muspratt[2]. Couch[3] has placed the genus *Cœlomomyces*, which belongs to the Phycomycetes, in a separate family of the order Blastocladiales, and he notes: "In most species of the Blastocladiales, perhaps all, the resting bodies are incapable of germinating before undergoing a period of drying, and retain their vitality for a long time, up to several years in the dry condition".

Walker[4] was able to infect some laboratory-bred larvæ of *A. gambiæ* (*A. costalis* Giles) with *C. africanus* in a cement tank, and it is probable that if regular drying up of the tank and refilling had been resorted to, further infections would have been possible.

The following are brief notes on my own experiment. (1) A large number (300–400) of infected *A. gambiæ* larvæ packed full of thick-walled sporangia were collected and put into jars containing water and soil from the breeding-place. When the larvæ were dead, the water was allowed to evaporate and the soil to become nearly, but not quite, dry, when the lids were placed on the jars. About 100 lb. of nearly dry 'mopane' clay soil, with which the fungus appears to be associated at Livingstone, Northern Rhodesia, was sent to Johannesburg together with the jars of soil containing the dead larvæ. All the material was left in the laboratory over the winter.

(2) More than eight months later, during the summer, the main bulk of soil was dumped in the centre of a concrete trough 4 ft. 3 in. in length, 1 ft. 5½ in. in breadth, by 5½ in. in depth. This was placed outside the laboratory so as to be exposed to the sun for 3–4 hours each day; and the soil, in the jars, containing the resting sporangia in the larval remains, was scattered on the lower part of the mound of soil in the trough. A roof was put over the trough at night to prevent a downpour washing any of the soil out of it.

(3) The trough was filled with rain-water, which was poured over the mound of soil; and *gambiæ* larvæ, hatched from eggs, were put into it. The water was allowed to evaporate to dryness every two or three weeks, and the trough to remain dry for three or four days before it was refilled and another batch of newly hatched larvæ put in. After the water had been evaporated once and the trough refilled, about fifteen out of a hundred larvæ of the second batch became heavily infected, and a few in later batches; but the experiment had to be discontinued because of the difficulty of obtaining a regular supply of *gambiæ* eggs, and because it was found that the climate of Johannesburg is too cool for the larvæ to grow normally owing to the high altitude of nearly 6,000 ft. above sea-level.

I believe that in experiments with this species of the fungus, it may be necessary to use rain-water and allow it to evaporate in the sun to about one third of its volume before infection can be expected, the germination of the resting sporangia perhaps being regulated by a slight increase in the concentration of the soil mineral salts in solution. This corresponds to the conditions of infection found in Nature.

Although the above experiment did not prove that indefinite infection of *A. gambiæ* larvæ by the fungus can be obtained in a confined space, I feel confident that, given suitable climatic conditions, this would be the case. It will greatly facilitate a study of the life-cycle of this genus of fungi, with the view of finding out if it can be used for the biological control of this and other dangerous species of mosquitoes.

I am greatly indebted to Dr. Botha De Meillon, under whose supervision the experiment has been carried out in the Department of Entomology of this Institute, and I wish to thank Dr. Mastbaum and staff of the Swaziland Medical Service for sending me eggs of *A. gambiæ* from Swaziland Protectorate.

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Johannesburg. July 4.

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Seasonal Variation in the Rate of Growth of Young Cattle

MANY investigations have been made on the rate of growth in young cattle, and a mass of detailed information on live weights and body measurements has been accumulated[1,2,3,4]. During the period 1927–33 the live weights of all the cattle stock (dairy shorthorns) at the College Farm, Nantcellan, were recorded at approximately monthly intervals, and the data for young cattle have recently been examined. The live-weight curve for the heifers reared for herd replacement has been found to follow that described in Great Britain[1], in the United States[2,3,4,5] and in South Africa[6]. There are, however, two observations from the Nantcellan records which are of special interest. The first of these confirms the findings of Hansen[7] that calves grow faster during the grazing season than when housed. The second is not in accord with Hansen's finding that calves born at the beginning of November do not grow as fast during the first six months as those born at the beginning of April.

(1) There is a seasonal variation in the live-weight gain of young cattle. This is illustrated by a comparison of the summer and winter gains of groups of heifers.

TABLE 1. AVERAGE SUMMER AND WINTER GAINS IN LIVE WEIGHT (LB.)

Group	Number of heifers in group	Summer	Winter	Summer	Winter
1	7	229	47	212	−38
2	5	218	85	143	−58
3	7	171	89	126	+61
Mean	–	206	74	160	−12

This variation is further illustrated by the daily gain for each month The average daily gain of sixteen groups of heifers consisting of fifty head in all, during the year 1927–31, are given in Table 2.

TABLE 2. AVERAGE DAILY GAIN PER MONTH (LB.)

July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June
1·54	0·93	0·75	1·06	0·36	0·85	0·38	0·48	0·13	−0·30	1·66	1·32

The rate of growth in late winter is low, and in April there is actually a loss in weight.

(2) The season of birth has an influence on live-weight gains during subsequent growth. The computed live-weight gains per 100 days according to season of birth is given in Table 3.

This table indicates the advantage that calves born during the autumn have over those born at other times. At 300 days of age, such calves weighed 53·5 lb. more, and at 600 days they weighed 101·5 lb. more, than the others. This may have been due partly to a higher pre-natal level of nutrition, as their dams were on grass during the last stages of pregnancy, and partly to the fact that autumn milk is usually richer in fat, and considerably richer in carotene, than April milk. The autumn-born calves were out on grass during their first summer, whereas the spring-born calves were kept indoors during their first summer.

TABLE 3. COMPUTED LIVE-WEIGHT GAIN IN LB. PER 100 DAYS

Season of birth	1st 100 days	2nd 100 days	3rd 100 days	4th 100 days	5th 100 days	6th 100 days	7th 100 days	1st 300 days	1st 700 days
Jan., Feb. and Mar.	125	121	110	98	112	85	12·5	356	663
April, May and June	118·5	127·5	105	96	109	35·5	14·5	351	606
July, Aug. and Sept.	116	131	107	107	60	46	73	354	640
Oct., Nov. and Dec.	136	141	129·5	84	105	77·5	64 5	406·5	737·5
Mean, Jan. to Sept.	120	126	107	100	94	55·5	33	353	636
In favour of Oct. to Dec.	16	15	22·5	−16	11	22	31·5	53·5	101·5

These figures are consistent with the practical farmers' view that it is easier to rear calves born in autumn than those born in spring, with the data of Jordan[8] on the relative mortality of autumn and of spring calves, with data collected here[9] on the seasonal variation in wastage among dairy stock and with observations on other species[10,11,12]. Full details will be published elsewhere.

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Electricity for Engineers

DR. HUGHES was on the whole very generous in his review[1] of my "Elementary Electric-Circuit Theory", but since he thinks that I have Ohm's law wrong, I should like to come to terms with him on that point.

I take no exception to Dr. Hughes's statement to the effect that Ohm's law merely expresses the fact that the ratio V/I is substantially constant for certain materials under certain conditions. On the other hand, Joule's law says in effect that the ratio P/I^2 is substantially constant for these same materials. In my derivation I specify a wire, and hence can use Joule's law. Use of the principle of conservation of energy in the form $P = VI$ gives Ohm's law from Joule's law or vice versa. The former is done on p. 20 of my book. In the preface I specify as a prerequisite a course in basic physics, in which Joule's law presumably should be learned; hence I do not expand upon it. I am very hard put to ascertain Dr. Hughes's difficulty with my statement on p. 21, that Ohm's and Joule's laws are interdependent, one being derivable from the other, unless he would have me add there, "through the principle of conservation of energy". However, I stated the use of this principle at the outset (p. 20) and feel that the repetition is scarcely necessary.

Lest this view of the interdependence of Ohm's and Joule's laws still may seem novel to Dr. Hughes, I refer him to p. 557 of the article by Prof. W. Thomson in the *Philosophical Magazine*, iv, 2 (1851), where the situation is explained, probably for the first time. If we call that ancient history, I then refer to "A Treatise on Electricity and Magnetism", by Mascart and Joubert (translated by Atkinson), 1, 238 (1883), for a restatement of this view in the middle ages, and to the *American Journal of Physics*, 11, 351 (1943), for a modern restatement.

Though the idea of potential was introduced into electrostatics by Poisson (1812) and named and developed by Green (1828), its application to current-carrying conductors was not clearly understood at the time Ohm discovered his law (1827) nor even by the time Joule discovered his law (1841). nor was the equivalence of work and heat firmly established. Hence the relation between Ohm's and Joule's laws could not become immediately apparent. However, this relation has been known for nearly one hundred years, and we now know that (aside from the commendable desire to be doubly sure) either Ohm or Joule might have been spared his trouble. Their laws are merely alternate ways of describing the same property of certain materials.

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[1] *Nature*, 157, 4 (1946).

THERE appears to be nothing fundamentally different in what Prof. Frazier and I say, only the method of approach, his from the historical scientific and mine from what I conceive to be the modern educational, especially for electrical engineers.

From time to time it becomes necessary to examine the routine of establishing the most complete and compact description of Nature, particularly for educational purposes. There are many historical aspects which in my view are unnecessary for educational purposes but are merely retained because they fit into a syllabus and can be examined and can usefully fill out an examination paper. They receive names, such as Kirchhoff, so that their form and use are retained under a label which can be easily remembered. I contend that a so-called law should describe Nature in a way which cannot be anticipated but is only revealed by experiment. In this instance we know what current electricity is, so there is no need to define it. Because current can convey power, the definition of potential difference is required. Current cannot escape, therefore Kirchhoff's first law tells us nothing, and the second law is simply an extension of the previous definition of potential and does not have to be discovered; similarly with Joule's law. These become scientific when verified with suitable accuracy by experiment, but are not independent descriptions of Nature. I am in favour of reducing the subject to the minimum, consistent with a rigorous adherence to definitions, so that those practising applications can be certain of their background without unnecessary excursions into history.

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John Tyndall's Radiation Experiment

IN the recently published "Life and Work of John Tyndall" no alteration has been made in his explanation of his experiment on radiation through a solution of iodine in carbon disulphide, rendering platinized platinum foil white hot.

The English translation of Clausius on "The Mechanical Theory of Heat" was published in 1879, with a preface by Tyndall; in the chapter "On the Concentration of Rays of Light and Heat", Clausius showed that in no circumstances could optical means produce an image hotter than the source of radiation. Tyndall supposed that the iodine solution transmitted infra-red rays only; if so, the source in effect was of infra-red only. But in Wood's "Physical Optics" (1934), p. 15, it is stated that, while bromine vapour stops all visible light, it passes so much ultra-violet that it gives good results as a screen for photography by ultra-violet light. The curve 23 in Plate 1 of that book, for a solution of iodine in carbon tetrachloride, shows absorption in the middle of the spectrum only, from green to violet; and so it appears that Tyndall's result was actually due to ultra-violet radiation, through the iodine screen.

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RESEARCH ITEMS

Chemotherapy of Typhus

C. H. Andrewes, H. King, M. van den Ende and J. Walker (*Lancet*, i, 177; 1944) found that *p*-sulphonamidobenzamidine and *p*-sulphonamidobenzamidoxine had protective and curative action on experimental typhus infections in mice. On analogy with the sulphonamides, it was anticipated that many related compounds would show anti-rickettsial activity and that some might prove even more effective. Such, however, was not the case. Andrewes, King and Walker (*Proc. Roy. Soc.*, B, **133**, 20; 1946) tested a large number of compounds of sulphonamido-amidine structure and found that anti-rickettsial activity was highly specific to *p*-sulphonamidobenzamidine and the corresponding amidoxine. Any modification of the molecule led to reduction or loss of activity. As a tentative explanation of their action, the interesting suggestion is made that these substances, by virtue of their amidine or amidoxine group, are utilized by the multiplying rickettsia for the formation of purines and pyrimidines in nucleic acid synthesis. They thus become built up into vital structures which cannot function normally owing to the foreign nature of the sulphonyl group. Clinical trial of these substances in the Naples typhus epidemic yielded negative results, the explanation of which is not yet clear.

Bone Formation in the Lung

THE scars in the apical part of the human lung, so commonly present in adults, have generally been regarded as healed tuberculous lesions. J. Davson and W. Susman (*J. Path. Bact.*, **45**, 597; 1937), however, believe that in most cases the scars result from the accumulation of siliceous dust at the lung apex which occurs progressively with advancing age. They recognize that sometimes the scars are of tuberculous origin and claim to distinguish between the two types on histological grounds. In both types of scar the fibrosis is frequently followed by calcification and actual bone formation. Davson (*J. Path. Bact.*, **57**, 171; 1946) found ossification in seven out of sixteen tuberculous scars and in eight out of twelve non-tuberculous ones. In the tuberculous scars, bone formation occurred as a replacement of calcified necrotic tissue, while in the non-tuberculous ones it developed directly in healthy fibrous tissue. In all cases true bone lamellæ were laid down and a marrow cavity developed.

Colpomenia peregrina Sauv. in Denmark

IN the early years of this century, a vesicular brown alga appeared on the Atlantic coasts of England and France, growing in quantity on rocks and other algæ in the tidal zone and just below it. In 1905–6 it caused alarm at Vannes (Brittany), where under certain conditions plants attached to young oysters became inflated with gas, so that the rising tide lifted them and the shells to the surface. Currents then drove them away from the oyster beds, causing great loss to the owners. Fortunately, there has never again been such damage. At first identified as *Colpomenia sinuosa*, which is widespread in warm and tropical waters, the alga was later given specific rank as *C. peregrina* Sauv. Possibly originating from the Pacific coast of North America, it spread up the English Channel to the North Sea (Terschelling, 1921) and also into the Irish Sea (Isle of Man, 1926). Now Søren Lund (*Rept. Danish Biol. Sta.*, **47**, 1942, published 1945) records it from Denmark, its most northerly location so far. The American slipper limpet appeared there in the 'thirties, probably carried with oyster fry imported from Holland; perhaps *Colpomenia* arrived in the same way. In the Limfjord (1940–42) it has survived prolonged freezing and summer temperatures rising to 20° C.; the salinity there may be no more than 26 per mille. Doubtless such a hardy alga will extend still farther north, but no harm is anticipated to oyster beds.

Endosperm Failure in Barley × Rye Crosses

THE successful production of hybrid plants from interspecific, intergeneric and even interfamily crosses has naturally led to investigation of the events which occur in some of the crosses which habitually fail. Rather surprisingly, it now appears that the actual production of a zygote is common, even in such wide crosses as between *Nicotiana* and *Petunia*, *Salpiglossis*, *Nicandra* or *Solanum*, or between *Hordeum* and *Secale*. W. P. Thompson and D. Johnston (*Canad. J. Research*, **23**, 1; 1945) show that in the cross *Hordeum vulgare* × *Secale cereale*, the early zygote is normal and remains healthy long after irregularities are evident in the endosperm. It dies when composed of about twenty-five cells, almost certainly as the result of faulty endosperm behaviour. After fertilization, the antipodals also behave normally, but the endosperm nucleus and its derivatives appear to have increasing difficulty in carrying out normal mitoses, although nuclear material still seems to be synthesized. Thus in place of an endosperm lining of numerous nuclei each with three nucleoli and twenty-one chromosomes, there are only a few rarely dividing giants having up to twenty nucleoli and at least a hundred chromosomes (in the only three-division figures observed). Cellular differentiation is never reached and the endosperm nuclei degenerate, so that, by the end of about six days, most of the embryo sacs have collapsed.

The Take-all Fungus

THE year 1943 brought unusually severe attacks of the fungus *Ophiobolus graminis* in the south of England (W. Buddin and S. D. Garrett, *Agriculture*, (3), **51**, 108; 1944). Soil temperatures higher than the average in the winter of 1942–43 favoured the underground spread of the fungus. Double the normal amount of rain fell in January 1943, leaching out soluble nitrogen, and nitrogen starvation of the host plant favours the disease. Soil moisture was adequate for the growth of the fungus on the roots until the end of May. A dry spell in June and July completed the havoc. Further instances are given of the devastating effects of including two or more consecutive white crops in the rotation. One part of a field had 66 per cent of the tillers with take-all in the second wheat crop, whereas wheat following potatoes in the other part had only 13 per cent infected tillers. The fungus may be carried on weed grasses. S. D. Garrett and R. W. G. Dennis have found *O. graminis* var. *Avenæ* to be fairly extensive in Scotland (*Trans. Brit. Mycol. Soc.*, **26**, 3 and 4; 1943). The variety has larger ascospores than the species.

Rotational Forces and Mountain Building

DISTURBANCE of the earth's axis of gyration is considered as a possible cause of crustal deformation by J. E. Fisher (*Amer. J. Sci.*, **243**, 606; 1945).

The author claims to have shown (*a*) that tilting of the axis by 10′, or a small translation of the axis, would be quantitatively sufficient to account for the development of great orogenic belts, even after allowing for ample wastage of work in friction and heat; and (*b*) that axial shifts of this magnitude could be brought about by denudation and large-scale transport of the resulting debris and its re-distribution as sediment, with continental glaciation and sub-crustal convection currents as contributing possibilities. He faces the fact that isostatic readjustments during denudation and deposition would be expected to neutralize the disbalancing effects from the start, and admits that this hypothesis is applicable only where the crust was unable to respond quickly to isostatic readjustment. These considerations make it improbable that axial disturbances set up by geological processes can ever have been a decisive factor in orogenesis. In a paper on "The Moon's Lack of Folded Ranges", R. T. Chamberlin (*J. Geol.*, 53, 373; 1945) expresses his suspicion that the isostatic response to sediment-transfer might limit the amount of axis-tilting much more than the author has thought. Chamberlin, however, points out that since rotational forces are much weaker on the moon, and transfer of sediment non-existent, these may be factors for consideration in trying to account for the absence from the moon of arcuate folded ranges like those which characteristically wrinkle the face of the earth.

Speed of Colloidal Particles

Miguel Ozorio de Almeida has shown that certain errors are incidental in some of the methods employed for measuring colloidal velocities (*An. Acad. Brasileira Ci.*, 17, No. 4; 1945). In determining these velocities by microscopic observation in a closed vessel, two hypotheses are made as an essential basis: (1) the motion of a particle with reference to the liquid is constant; (2) the variations of speed which are observed are due to electro-osmotic currents. Although it is generally admitted that the electro-osmotic movement in the interior of the vessel obeys the equation theoretically established by V. Smoluchowski, nevertheless the various deductions from this equation are open to a considerable amount of doubt. The author shows that it is possible to represent the results of experiments, not very rigorously but with sufficient accuracy, by a parabola of the form $V = a + bz + cz^2$. It is admitted, however, that experimental results can be represented equally well or even better by a different equation, and a field for further research is open to investigation in this sphere.

Acetylenic Ketones

A group of ketones previously almost unknown, containing the grouping $-CO.C \vdots H$, containing one active hydrogen atom, has been investigated by Sir I. M. Heilbron and collaborators (*J. Chem. Soc.*, 39, 45, 52, 54; 1946); with K. Bowden, E. R. H. Jones, P. Smith and B. C. L. Weedon. A new method of preparation, consisting of chromic acid oxidation of the corresponding secondary alcohols, best in acetone solution, was worked out, and many new compounds prepared. The acetylenic hydrogen is markedly acidic, and although the ketones show no appreciable tendency to polymerize they readily undergo a variety of addition reactions. The acetylenic di-secondary glycols from crotonaldehyde and benzaldehyde are smoothly oxidized to diketones, but the glycol from butaldehyde gives mostly a keto-alcohol, further oxidation to the diketone being much more difficult. The addition of amines and dienes was studied, as well as the hydration of some related compounds, and absorption spectra were obtained.

Composition of Technical D.D.T.

The insecticide D.D.T. (a contraction of the name dichloro-diphenyl-trichloroethane) is made by the condensation of chloral (or its alcoholate or hydrate) with chlorobenzene in the presence of sulphuric acid. There are forty-five possible isomers. A paper by twelve authors (*J. Amer. Chem. Soc.*, 67, 1591; 1945) records studies of the composition of several samples of commercial D.D.T. and a sample of by-product oil recovered from a process of refinement. Technical D.D.T. was found to contain upwards of 70 per cent of 1-trichloro-2,2-*bis*(*p*-chlorophenyl)-ethane(*pp*′-D.D.T.), the most active insecticidal ingredient. The major impurity was 1-trichloro-2-*o*-chlorophenyl-2-*p*-chlorophenylethane (*op*′-D.D.T.) but lesser amounts of twelve other organic impurities were found. A number of syntheses, and work on the structure of the by-products, also figure in the paper.

New Measures of the Sodium Line D_1 in the Solar Spectrum

J. Evershed has given the results of further investigation on the shift of the sodium D_1 line in the solar spectrum (*Mon. Not. Roy. Ast. Soc.*, 105, 200; 1945). In 1938 Evershed summarized the results of his measurements of this line compared with vacuum-tube emission as follows: ". . . unlike the lines of iron or calcium, the sodium line is found to give the same shift towards red at the centre of the disk as at various points on the limb, and this shift agrees very closely with the Einstein relativity effect" (*Mon. Not. Roy. Ast. Soc.*, 93). In a long series of measurements commencing in May 1938, it has been found that a sudden change may take place in the shift or wave-length of the line, and this may occur in the spectra of the centre of the disk or in those obtained near the limb. Various possibilities are suggested to explain this effect, but they are shown to be untenable; only one explanation is feasible—that the departure from the normal redward shift must be due to changes in the sun, and may readily be attributed to movements of the sodium vapour. There is an average excess over the relativity effect of 0·0022 A., and this might be interpreted as a downward movement at this high level in the reversing layer, the sodium layer descending at about 100 metres a second, and thus partaking in the downward motion of the higher chromosphere represented by the lines H_3 and K_3 of calcium, in which, as Evershed showed in 1931, the excess shift over relativity implies a motion of 940 metres per second descent. There are discrepancies in the shifts near the sun's limb, although the mean shifts for each of the three years 1943, 1944 and 1945 are in good agreement, and the shift of D_1 by a greater amount than relativity predicts is a problem awaiting a satisfactory solution. The total shift of the line at the east and west limbs gives a value of the solar rotation at a high level in the reversing layer. It indicates an increase in the angular speed with heights above the photospheric level and thus confirms results which have been previously obtained.

ROYAL SOCIETY OF CANADA

ANNUAL MEETING

THE Royal Society of Canada held its annual meeting at the University of Toronto during May 19–22 under the presidency of Dr. E. S. Moore, head of the Department of Geology in that University. The following new fellows were elected in the scientific sections: Section III (Chemical, Mathematical and Physical Sciences): Dr. Helen S. Hogg, of the David Dunlap Observatory; Dr. L. H. Howlett, of the National Research Council; Dr. C. A. Winkler, of McGill University. Section IV (Geological Sciences): Dr. D. R. Derry, of Ventures Ltd., Toronto; Dr. H. C. Horwood, of the Ontario Department of Mines; and Dr. H. M. A. Rice, of the Geological Survey of Canada. Section V (Biological Sciences): Dr. Louis Berger, of Laval University; Dr. I. McT. Cowan, of the University of British Columbia; Dr. James Craigie, of the Toronto School of Hygiene; Dr. R. K. Larmour, of the University of Saskatchewan; Dr. A. E. Porsild, of the National Museum; and Dr. R. F. Shaner, of the University of Alberta.

The Flavelle Medal was awarded to Prof. William Rowan, of the University of Alberta, for his pioneer experiments on bird migration, in which he has shown that crows will fly north instead of south in sub-zero November temperatures of Alberta after being exposed to spring-like conditions of progressively longer days artificially produced.

The Henry Marshall Tory Medal was awarded to Dr. J. S. Foster, of McGill University, for his war-work on radar.

Dr. Moore delivered his presidential address on the evening of May 20, his subject being "Our Earth". He dealt particularly with the relation of life to the earth, stating that rocks laid down long before the stage that first left evident remains of organisms have no proper explanation than that living things must have been present to produce them. Grenville crystalline limestone is one of these layers and indicates that life of some kind must have existed 1,800,000,000 years ago. Man's effect on the earth looms large in his own estimation, but his time—a million years—is but a 'flash in the pan' to what preceded him. That he may destroy the earth with atomic energy is feared by some, but seemingly geologists as well as physicists consider this most improbable. Uranium, the key material for release of the energy, is more abundant in the crust of the earth than inside, yet only one pound of it is produced annually to every 200 pounds of the gold that is thought to be very rare. Fissionable material (uranium and thorium) is too scarce and too scattered through the mass of inert material for any explosion to have more than a local effect.

Prof. J. D. Cockcroft, of the University of Cambridge, director of the Canadian Experimental Atomic Energy Plant, and recently appointed director of the British Atomic Energy Research and Development Station at Harwell, Berks, gave the popular lecture, which was on "Atomic Energy" and dealt largely with the slow reactions which occur in atomic piles. The National Institute for Nuclear Research is being built up at Chalk River by the Canadian Government around a pile which uses many tons of heavy water and uranium. Laboratories for nuclear physics, technical physics, radio-chemistry and medical research have been established. A high-power pile will shortly be in operation, which will be the most powerful research apparatus of this kind in the world. This should make possible many new types of physical experiments, as well as the production on a large scale of labelled or radioactive atoms for biological, medical and chemical research, of substitutes for radium such as radio-cobalt, and of plutonium for study of power generation.

In Section III the retiring president, Prof. C. T. Sullivan, of McGill University, delivered an address on "Some Investigations in the Projective Differential Theory of Scrolls". Prof. J. D. Cockcroft gave an invited paper on the atomic pile as a research tool, and Prof. J. S. Foster described the cyclotron now under construction at McGill University.

Among many interesting papers may be mentioned a group from the Canadian nuclear research laboratories at Chalk River, Ontario, mainly devoted to new instruments and techniques, and a group from the Dominion Astrophysical Observatory near Victoria, B.C. A spectrograph was described by M. F. Crawford and his collaborators of the University of Toronto. It was stated that this may replace the ordinary spectrograph for most Raman spectroscopy. D. C. Rose and J. S. Marshall, of the Canadian Army Research Establishment, demonstrated an apparatus, developed during the War, for the precise measurement of the velocities of projectiles, and showed how the apparatus, after slight modification, could be used to measure the speed of sound.

In the presidential address of Section IV, Dr. B. R. MacKay described the stratigraphy and structure of an area 100 miles long and 35 miles wide in the Rocky Mountain foothills belt of Central Alberta. A succession of sediments ranging in age from Devonian to Tertiary with a thickness of 26,000 ft. have been subjected to thrust faulting, folding and later thrust faulting. The area embraces an important group of bituminous coalfields, one of which is at an altitude of more than 6,000 ft.

Dr. W. E. Cockfield and A. F. Buckham described a phenomenon resembling sink-holes in the white silt deposits of Kamloops, B.C., and gave evidence to show that they developed by removal of materials in suspension, and not by solution in circulating underground waters. Dr. T. L. Tanton, in describing the relations between the hard and soft iron ore at Steeprock Lake, Ontario, interpreted the hæmatite deposits not as a surficial weathering product but as a late phase of a succession of mineral deposits introduced by hot solutions from depth at this locality. Dr. H. V. Warren and C. H. Howatson gave the results of a series of investigations carried on in British Columbia, in which it was noted that the zinc and copper content of some plants reflect, in some areas to a startling extent, the zinc and copper content of the underlying soils and rocks. Dr. J. E. Thomson presented the results of detailed mapping in the Kirkland Lake gold-bearing area, and explained the phenomena supporting his interpretation of a great angular and erosional unconformity between the Keewatin volcanics and the Timiskaming sedimentary-volcanic complex of that area. Dr. W. W. Moorhouse dealt with norites and related rocks at Eagle Lake, Ontario. The norite has been locally altered by younger granites and solutions derived from them; in the deuteric or late stage there was a development of concentrations of titaniferous magnetite, apatite and other accessory minerals. Nodular and lenticular masses of titaniferous magnetite are

believed to have segregated in immiscible liquid fractions.

The presidential address of Section V was given by Dr. B. P. Babkin, of McGill University, on "Antagonistic and Synergistic Phenomena in the Autonomic Nervous System". Most internal organs have a double nerve supply of which one is excitatory (sympathetic) and the other inhibitory (parasympathetic), that is, they work against each other. For the digestive glands, however, the parasympathetic works with the sympathetic, both giving stimulation. There are no true inhibitory nerves, and secretion is inhibited only through reducing the blood supply by vasoconstriction.

Dr. W. Rowan presented an invited review of investigations upon the factors influencing migration of birds, and outlined a new theory of the origin of speech. An important group of papers upon physiological characteristics of fishes which influence their distribution and their behaviour was presented by C. W. Andrews, E. C. and V. S. Black, J. S. Hart, and F. E. J. Fry, the last bringing forward notable general considerations regarding controlling and limiting factors in environment. Two papers by Kenneth Graham discussed certain fundamental aspects of the physiology of codling moth larvæ and described a new disease of black-headed budworms.

In the field of botany, five new species and two suggested new genera were reported among seed-borne fungi, and conifer-borne species of *Tympanis* were described. Dr. A. H. Hutchinson presented three papers giving original methods that are being applied to ecological studies in British Columbia forests. A study by Herbert Stern of pollen cells and pollen mother-cells at the time of division discovered an extraordinary increase in permeability. An investigation by Dr. William Leach of oxygen and nitrogen respiration provided interesting indications of oxidative anabolism in a number of germinating seeds, in various tissues, with different food reserves, and in *Aspergillus* growing on media with different sugars.

Dr. Madge T. Macklin and Dr. Louise Hopkins reported a statistical study in children of two kinds of congenital nerve deafness which are hereditary and both dependent upon recessive genes. However, it appears that there is occasional departure from the rule that all children of parents who are both affected with the same recessive defect are affected. Dr. R. G. Sinclair discussed the reactions of mustard gas with cephalins such as phosphatidyl serine and phosphatidyl ethanolamine. The resultant compounds cannot be dispersed in water and their base-binding capacities are considerably lower than those of the corresponding lipids. Drs. S. D. Simpson, S. H. Zbarsky and L. Young reviewed briefly their investigations of the toxicity and antidotal activity of British Anti-Lewisite (*BAL*), 2,3-dimercapto propanol, and of related thiols. These studies were greatly facilitated by the use of radioactive sulphur (S^{35}) which was incorporated in the compounds under investigation.

The officers of the Royal Society of Canada elected for 1946–47 were as follows: *President,* Dr. H. A. Innis, professor of political science in the University of Toronto; *Vice-President,* Dr. W. P. Thompson, professor of biology in the University of Saskatchewan; *President, Section I,* Pierre Daviault, Ottawa; *President, Section II,* Dr. Alexander Brady, associate professor of political science in the University of Toronto; *President, Section III,* Dr. E. L. Harrington, professor of physics in the University of Saskatchewan; *President, Section IV,* Dr. Bruce Rose, of the Department of Geology, Queen's University, Ontario; *President, Section V,* Prof. J. R. Dymond, professor of systematic zoology in the University of Toronto.

NATIONAL RESEARCH COUNCIL OF CANADA

A MEDICAL RESEARCH DIVISION

A DIVISION of Medical Research has been established by the National Research Council of Canada to carry on work previously directed through the Associate Committee on Medical Research. Dr. J. B. Collip, director of the Research Institute of Endocrinology, McGill University, Montreal, chairman of the former Associate Committee, has been appointed director of the Division, and Dr. G. H. Ettinger, professor of physiology, Queen's University, Kingston, assistant director. A new Committee on Medical Research will advise on questions of policy and with respect to medical problems which should be investigated. Under the new organisation of this work, the National Research Council will continue to support medical research mainly in the existing medical schools and hospitals throughout Canada, rather than through the establishment of medical research laboratories and appointment of medical research workers under its own auspices. The general subject of medical research was sponsored by the National Research Council just before the War at the request of the Canadian Medical Association and the Royal College of Physicians and Surgeons. On the outbreak of war, the Associate Committee on Medical Research offered its services through the National Research Council to the Dominion Government for the co-ordination of war-time medical research.

Most of the war problems investigated by the Associate Committee on Medical Research were supervised by four subcommittees, all with members from the Services. The Subcommittee on Shock and Blood Substitutes (chairman, Dr. C. H. Best) directed researches through regional groups in Toronto and Montreal on the fundamental nature of shock, on the use of isinglass as a blood substitute, on the preparation, properties, storage and transportation of dried human blood serum, and on methods of preservation of whole blood and red blood cells. It acted as adviser to the Connaught Laboratories, the Canadian Red Cross Society, and the Department of Pensions and National Health, in the matter of preparation of dried serum, and to the Royal Canadian Army Medical Corps in the preparation of a film demonstrating the recognition and treatment of shock. It issued memoranda on the "Early Recognition and Treatment of Shock" and on the "Organization and Operation of a Blood Bank".

The Subcommittee on Infections (chairman, Dr. Duncan Graham) organised researches on the diagnosis and treatment of wounds infected with gas gangrene and other organisms, and pioneer experiments on the local application of sulphonamides. It supervised the production of typhus vaccine and Shiga toxoid, and made suitable recommendations to the Department of National Defence concerning their use. It instituted experiments on methods of

production and use of penicillin. From its pilot plant in Toronto it supplied large quantities of penicillin to the Department of National Defence, and less amounts for civilians, until the commercial production in Canada was able to supply ordinary needs. It undertook the preparation of an influenza vaccine. It prepared recommendations for prevention of infection of wounds. It advised the Department of National Defence on questions of bacteriological significance as often as requested.

The Subcommittee on Surgery (chairman, Dr. Wilder D. Penfield) supervised researches through regional groups in Montreal, Toronto, London and Winnipeg, and through sections on burns, orthopædics, plastic surgery, surgical radiology, thoracic surgery, and traumatic injuries of the nervous system. These included investigations on the treatment of burns; infected wounds and peripheral nerve injuries; treatment of low-back pain with and without sciatica; use of penicillin; skin grafting; bone grafting; facial prostheses; recognition of non-metallic foreign bodies by X-rays; and surgical problems of air transport of wounded.

The Subcommittee on Industrial Hygiene and Industrial Medicine (chairman, Dr. D. Y. Solandt) was concerned mainly with health problems in industries active in the manufacture of munitions and supplies.

The Associate Committee also provided the Department of National Defence with recommendations in respect of nutrition and prepared a memorandum on problems of nutrition in Canada, which was submitted to the Ministry of Food and the Medical Research Council in Great Britain.

In carrying out this programme of medical research, the Associate Committee had the co-operation and assistance of several hundred leading physicians and surgeons throughout Canada, who were keenly interested in this subject. Their able and willing contributions enabled the Committee to plan and direct medical research during the War on a high level of efficiency. Under the new arrangement the existing need for expansion can be met and continuity of research from year to year in selected fields will be provided for on a permanent basis.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

THE annual report for 1944–45 of the National Institute of Economic and Social Research*, referring to the steps taken to execute the research policy for the immediate post-war years outlined in the previous report, refers to an inquiry into distribution, for the planning, direction and organisation of which Mr. Hugh Weeks is responsible as chairman of a small technical committee. A second step is the decision to start a study of the building industry, for which purpose Mr. I. Bowen has accepted an appointment as research associate. The further development of the Institute's research policy depends upon the availability of trained applied economists who possess the experience and maturity for handling large-scale projects. With minor exceptions, there have been in Britain no trained economists coming from the universities for five years, while the demand for applied economists is not falling off with the end of the War. The year that has passed since the Institute's post-war research policy was outlined confirms the prediction then made that demands for guidance would be made on an unprecedented scale.

A joint exploratory committee has been set up with representatives of the Institute of Chartered Accountants to investigate the field of work in which accountants and economists have a common interest and which would repay more detailed co-operative investigation. The first task of the committee is to explore the varying meanings and uses of terms such as 'income', 'expenditure', 'capital', 'saving', 'profit', 'loss', 'maintaining capital intact', 'stock valuation', and so on. At the end of 1944 the Institute intimated to the universities its desire to devote certain accumulated funds to university research in economics and allied social sciences in the United Kingdom during the post-war transition period; as a result it has been decided to adopt a scheme of senior research fellowships and grants-in-aid to operate over the next two years.

The second and third issues of the Register of Research in the Social Sciences were prepared and circulated, the response to the second register being very encouraging. Until June 1945 the Institute continued to provide secretarial and other facilities for the work of the National Service Committee for Social, Economic and Statistical Research, advisory to the Ministry of Labour. Inquiries completed for publication during the year and mentioned in the report include that of Prof. J. R. Hicks and Mrs. U. K. Hicks on the "Incidence of Local Rates in Great Britain", Prof. Sargant Florence's "Investment, Location and Size of Plant: an Inquiry into the Structure of Different Industries", and Dr. T. Balogh's "Studies in Financial Organisation".

Of major inquiries continued throughout the year, that on national expenditure, output and income, 1920–38, directed by Mr. Richard Stone, has resulted in two papers read to the Royal Statistical Society and an Occasional Paper, "Consumers' Expenditure in the United Kingdom, 1920–38; Interim Results and Analysis". The whole inquiry endeavours to present a consistent set of estimates of the components of the national expenditure, output and income over the period, and on the basis of this material to provide an economic analysis and interpretation of the changes which have taken place.

The investigations on the distribution of the product of industry under Dr. L. Rostas led to an Occasional Paper, "Productivity, Prices and Distribution in Selected British Industries". The ultimate purpose of the investigation is the analysis of the material collected to discover the dominant factors which determine distribution and prices in industry. Statistical investigations of prices, costs, distribution and productivity in different-sized units within selected industries have been made possible by the assistance of the Board of Trade. In the third major project, on the measurement of Colonial national incomes, Miss Deane is completing the work which can be undertaken in Britain and has prepared an Occasional Paper on the "Measurement of Colonial National Incomes: An Experiment". The next stage of the work will be a field study in Africa, for which purpose a Colonial research fellowship has been awarded to Miss Deane by the Colonial Office. Mr. R. Titmus's

* National Institute of Economic and Social Research. Annual Report, 1944–45. Pp. 22. Publications and Programmes. Pp. 22. (London, 1945.)

inquiry into disease mortality and its changing distribution in England and Wales has now been entitled "Distribution of Health and Location of Industry", and a report on the findings is in preparation. "The British Banking System, 1939–45" will be ready for publication shortly, and the Institute has also been able to assist an inquiry into the influence of social factors on the infant mortality rates in England and Wales before the War. Although the first six months of 1944 constituted the most satisfactory period in the working life of the Library, considerable damage was caused to the material in it by the flying-bomb which wrecked the Institute's premises in July, and most of the material had to be stored.

A separate list of publications and programmes of the Institute dated September 1945 has also been issued. In Sections 1 and 2 of this pamphlet are listed the titles and authors of the books already published or in the press in the two series, Economic and Social Studies and Occasional Papers. Section 3, which gives an account of work in active preparation for the press, contains further information regarding the scope of some of those major research programmes which are sufficiently advanced to permit an account of the series of publications which they are expected to produce.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

ANNUAL REPORT

THE recently issued annual report for the year 1944 of the Indian Association for the Cultivation of Science, in addition to the financial statement and accounts of the various funds and the budget estimates for 1945, includes a list of papers appearing in the four issues of the *Indian Journal of Physics* and the *Proceedings of the Indian Association for the Cultivation of Science* published during the year.

A report on the scientific work of the Association by Prof. K. Banerjee is appended, with a list of papers. Detailed studies on the extra reflexions in Laue photographs indicate that these reflexions may be divided into three classes. The first, which has been observed by C. V. Raman and by Lonsdale and Smith for diamond, by C. R. Bose and Prof. Banerjee for phloroglycinol dihydrate and by the latter and R. K. Sen for benzil, shows extremely sharp spots which fall off in intensity very slowly with increase of deviations from the glancing angles for Bragg reflexions. The second type of extra reflexion consists of sharp lines in the Laue photographs and has been closely studied in benzil, where the reciprocal lattice points have plane extensions. The third type is the very commonly studied type of diffuse reflexions. Investigations into the atomic arrangements of some organic crystals, including benzil and phenanthrene, by the method of Fourier analysis, are being made. Other X-ray investigations have covered the solid solutions of metals and salts in glass, indicating that the introduction of gold and platinum induces devitrification, while these metals enter into the glass in fine colloidal states.

The effect of change of wave-length of the exciting radiation on the fluorescence of naphthacene has been studied by exciting a crystal of anthracene containing traces of naphthacene, and it has been shown that the positions and numbers of fluorescence bands do not change with wave-length of exciting radiation. The substance continues to fluoresce even when the wave-length of the exciting radiation is between that of the longest wave absorption band of anthracene and that of naphthacene in that material. It has also been found that the position and number of fluorescence bands of anthracene, perylene, phenanthrene and naphthacene in benzene are independent of the wave-length of the exciting radiation, and the longest wave-length in the absorption spectrum of a substance is its critical wave-length for excitation of fluorescence; the fluorescence becomes very strong when the exciting radiation lies in any absorption band of the substance.

The effect of solvents on the absorption and fluorescence spectra of naphthacene has also been studied, and Raman spectra of ethylene dibromide, ethylene chlorohydrin, propyl bromide and dichlorethylene have been investigated in the solid phase at the temperature of liquid oxygen as well as in the liquid state. Other investigations have covered the optical anisotropy of organic crystals such as anthracene, *m*-dinitrobenzene, tetrachlornaphthalene and phloroglucinol dihydrate; the magnetic properties of molybdenite crystals; and the Kerr effect in glass.

HEALTH SURVEY IN INDIA

THE Singur Health Centre, which is attached to the All India Institute of Hygiene and Public Health, Calcutta, carried out a general health survey of the Unions of Singur, Bora, Balarambati and Begampur, a predominantly Hindu area of 33 square miles with a total population of 68,000 people, situated about 22 miles from Calcutta, during January–August 1944. The report of this survey, which is obtainable from the Institute, is summarized in an article in *Science and Culture* (11, 489; 1945–46) by Dr. R. B. Lal, who also addressed the Calcutta Rotary Club in February 1946 on the same subject.

The scientific worker of to-day, said Dr. Lal, is not content to wrest secrets from Nature; he also wants to know why the results of scientific research are not used to improve the lot of those masses of people who still live in a primitive way. Dr. Lal's efforts to establish a well-planned health service in the area surveyed will command the support of all public-spirited people.

The area is much overcrowded. About 65 per cent of the people have less than 36 sq. ft. of floor space and the housing conditions are poor. This probably accounts for the high incidence of hookworm disease, especially among males. Anæmia is a striking feature. The chief causes of death are dysentery, pneumonia, the typhoid fevers and malaria. The survey was carried out in a non-malarial season, but malaria needs special attention. *Anopheles philippensis* is believed at present to be the only vector of malaria in the area, but other species may also be involved. "The Bengal Famine does not seem to have affected this area in 1943 . . . but evidence of stress was seen later." Less than 50 per cent of the population are between the ages of sixteen and fifty-five, so that the active population includes children and old people. The proportion of active people is, however, low. In India as a whole, 44 per cent of the population contribute to the family income; but in Bengal only 29 per cent do so and in the Singur area 31 per cent; the difference is due to the fact that women in the

Singur area do not undertake remunerative occupations.

Most of the people are engaged in agriculture; the land is intensively cultivated, but less than 50 per cent of males are engaged in this work. The number of cattle is large in proportion to the population, but most of them are of inferior stock. Nevertheless, many people work in industries and move daily to and from Calcutta, thus creating epidemiological problems. Discussing the economics of the area, Dr. Lal points out that 36 per cent of the 11,700 families in it fail to balance their budget and that 18 per cent of them are in a hopeless economic position. Little is spent on education and, although much is spent by the people on medical care, the loss due to sickness is "colossal". Wastage of life of young children and the retarded growth of children as a whole are serious problems. When a child is one year old in this area it is already one year behind its American brother in weight and half a year behind in height. Malnutrition is one of the main causes of this. Only 10 per cent of children under two receive more than 10 ounces of milk. Other causes are lack of qualified medical men and large numbers of "practitioners of unscientific medicine". Late weaning also contributes, children often not being weaned until the next pregnancy occurs. The outlook on food is mainly determined by tradition, the diet being deficient in fats, calcium and vitamins. Demons are regarded by 27 per cent of the people as the cause of disease and 34 per cent blame God for it.

Dr. Lal concludes that economic prosperity is associated with better health and that the evidence provided by the report does not suggest that education will help to reduce sickness. "Just literates are worse than illiterates." The birth-rate is not likely to be reduced unless there is a check on the marriage-rate and postponement of marriages; but there is at present little hope of those reforms. There is no evidence that alcohol or narcotics play any part on the national loss due to illness.

This careful survey provides many hard facts and much food for thought. It is evident that India need not go beyond her own sons for wise guidance in the reforms that are so urgently needed. G. LAPAGE

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

JUBILEE CONGRESS

THE jubilee congress of the Union was held at Tunbridge Wells during July 9–13 at the invitation of the Mayor and the Tunbridge Wells Natural History Society. The Mayor, Mr. T. C. Allen, in welcoming the Union to its place of birth, spoke of the tremendous strides made by science during the fifty years since the inception of the Union, but he said that the recent development of the atom bomb made him apprehensive of the future.

The presidential address, delivered by Prof. J. D. Bernal, was entitled "The Place of Scientific Societies in the New World". In outlining the historic development of regional scientific societies, Prof. Bernal spoke of the notable part played by them during the hundred years before the War, but in recent years their work has been overshadowed by that of the great laboratories and institutes. Amateurs often wonder if it is worth while endeavouring to compete with the professional scientific worker, who is provided with the money and man-power which modern science seems to require. This results in a divorce between science and the public which is to be deplored. There must not be professional scientific workers and a lay public. Everyone must be a scientist for, while common sense can go a long way, scientific decisions are necessary to solve the problems of to-day. The health of science depends upon the interest and service of a large proportion of the population, and local and regional scientific societies are best fitted to organise the collaboration of the public with science. Prof. Bernal said that in operational research the services of people actually employed in operations are necessary to obtain the facts without which scientific analysis would be of no use. The methods used are those of simple statistical survey. As an example, rationing has for the first time in history been done scientifically and not arbitrarily, and the result achieved is shown by comparing the deterioration of health in Great Britain during the First World War with the average increase of health during the Second World War. Again, planning with due respect to the features of the country and the feelings of the inhabitants now replaces ribbon development. The opinion of the housewife is now being sought on domestic matters. No one in the soap trades ever considered the physical and chemical make-up of washing-up soap. It has been sold for the amount of lather it makes, not because it does the work. In solving household problems rather than finding out what people never had, it is necessary to find what they know and what they have experienced, and to draw conclusions therefrom.

No government department, whether of housing, agriculture or health, can act wisely unless it has information got by a widespread net of informants, and the local scientific societies can form such a net. The surveys undertaken by the Union need to be intensified, multiplied and their results effectively used. The scientific societies should link the efforts of the schools, universities, museums and libraries, and the work will be not less interesting and satisfying if it be turned to the service of national welfare.

In addition to the presidential address the following sectional addresses were delivered: "Wealden Iron-working, its Sites and the Products", by E. Yates; "Roman Roads in the Weald", by I. D. Margary; "The Vegetation of the Wealden Area", by F. Rose; "The Changing Vegetation of Britain", by Prof. W. H. Pearsall; "Coastal Preservation and Planning", by J. A. Steers; "Life in Medieval Times in a Sussex Manor", by J. E. Ray; "The Effects of the Weather on Seasonal Responses of Animals and Plants", by Major H. C. Gunton; "Fifty Years of Wealden Geology", by Dr. J. C. M. Given; "Aeolian or Marine? The Problem of the Folkestone Beds", by R. Casey; "Charles Darwin's Life at Downe, Kent", by Dr. O. J. R. Howarth (Pedler Lecture of the British Association); "Mammalian Carriers of Infection", by Dr. E. Hindle; "Land and Freshwater Mollusca of the Tunbridge Wells Area", by Dr. L. B. Langmead; "Some Birds of Norfolk", by I. Murray Thomson.

Excursions were conducted during the afternoons to places of scientific interest within the area.

The presidential and sectional addresses will be published with the transactions in Vol. 51, 1946, of the *South-Eastern Naturalist and Antiquary*.

The Congress for 1947 will be held at Brighton during the second week in July, the president-elect being Prof. F. Balfour-Browne.

FORESTRY AND THE PUBLIC WELFARE

A SERIES of papers was read before the American Philosophical Society at its autumn general meeting on November 17, 1944, and has since been published ("Symposium on Forestry and the Public Welfare", *Proc. Amer. Phil. Soc.*, 89, No. 2, July 18, 1945. Lancaster Press Inc., Lancaster, Pa.). The titles of the papers presented indicate of themselves the importance of this meeting, at which a whole session was devoted to the subject.

Perhaps one of the most interesting papers, historically and to the general public, is the last one printed, entitled "The American Philosophical Society and the Early History of Forestry in America", by Prof. Gilbert Chinard, of Princeton University. This paper occupies half this issue of the *Proceedings*, and cannot be dealt with here ; it merits a review to itself. The other papers are : "Forests in Relation to Soil and Water", by Raphael Zon, Lake States Forest Experiment Station ; "Wood in the National Economy", by Carlile P. Winslow, Forest Service, U.S. Department of Agriculture ; "World-wide Needs of Woods as a Land Conservation Crop", by W. C. Lowdermilk, Soil Conservation Service ; "America's Role in Meeting World Timber Needs", by E. I. Kotok, U.S. Forest Service ; "Forest Conservation ; A Task in Engineering and in Public and Private Co-operation", by Wilson Compton, National Lumber Manufacturers Association ; "Public Control of Cutting Practices on Private Timberlands", by Joseph F. Kaylor, Maryland State forester ; "The Role of Federal, State, and Local Governments in Promoting Forestry", by John D. Black, Harvard University. These papers are by well-known authors in their several subjects, and cover, or very nearly cover, the whole business and research work connected with forestry. The theme underlying Zon's paper is introduced in his opening paragraph : "The entire philosophy of the role of the forest is based on the ability of the forest to prolong the water cycle from its inception as falling precipitation to its final disposal as runoff into streams and oceans. The longer the water is retained on the land, the greater is its usefulness in nurturing crops and trees, in maintaining a regular supply of water in streams, and in preventing the soil from washing. Simple as this relationship is, yet so many are the factors which play related parts in this influence, so great is the difficulty of observing them with precision, and so wide the range of economic interests affected, that considerable divergence of opinion still exists on the subject."

The following extract from Winslow's "Wood in the National Economy" is a war record of considerable value. "During this modern War," he says, "as in all past wars, wood has proved indispensable. The normal peace-time production of wood products has been radically curtailed in spite of the staggering total of thirty-seven billion board feet of lumber consumption in 1943. Wood has quartered, transported, and gone into munitions for our troops throughout the world. We are all aware of the vast quantities of lumber going into the construction of military buildings. However, it is likely that few comprehend fully the list of wood items demanded by war's insatiable appetite : wood for hangars, scaffolding, boats, wharves, bridges, pontoons, railway ties, telephone poles, mine props, anti-tank barriers, shoring, shipping containers, and air-raid shelters ; plywood for airplanes, blackout shutters, prefabricated housing, concrete forms, ship patterns, assault boats, ship interiors, truck bodies, and army lockers ; fuel for gasogenes, for trucks and tractors ; pulp and paper for surgical dressings, boxes, cartridge wrappers, building papers, pasteboards, military maps, laminated plastics, gas-mask filters, printing, and propaganda distribution ; synthetic wood fibers, such as in rayon, artificial wool and cotton, for clothing, parachutes, and other textiles ; wood cellulose for explosives ; wood charcoal for gas masks and steel production ; rosin for shrapnel and varnishes ; turpentine for flame throwers, paint, and varnishes ; cellulose acetate for photographic film, shatterproof glass, airplane dopes, lacquer, cement, and molded articles ; wood flour for dynamite ; wood bark for insulation, tannin, and dyestuffs ; and sugar from wood for cattle feed and alcohol for explosives and rubber.

"The amount of lumber used for containers for war material this year [1943] is more than sixteen billion board feet, or approximately one-half of the total volume of our lumber production.

"Long suffering in past years from the encroachment of competitive materials, wood has become the wartime champion substitute of all time. National security demands that it always be available."

The other papers provide an important contribution to forestry literature, more especially those by Lowdermilk on "World-wide Needs of Woods as a Land Conservation Crop", and Wilson Compton's "Forest Conservation : A Task in Engineering and in Public and Private Co-operation".

LECTURERS (2) IN EXPERIMENTAL PHYSICS—The Registrar, The University, Manchester 13 (August 31).

MOULD ROOM TECHNICIAN—The Secretary-Superintendent, Addenbrooke's Hospital, Cambridge (August 31).

DIRECTOR OF THE CAPE TECHNICAL COLLEGE—Messrs. J. A. Ewing & Co., Ltd., Finsbury Court, Finsbury Pavement, London, E.C.2 (August 31).

ASSISTANT COMMISSIONER FOR ARCHÆOLOGY to assist the Commissioner in the administration of the Sudan Antiquities Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Archæology' (August 31).

CHEMIST and a ZOOLOGIST for research on hydrography and plankton at the Marine Biological Laboratory, Millport—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (August 31).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF GEOLOGY, and LECTURERS (2) IN VETERINARY BACTERIOLOGY—The Registrar, The University, Liverpool (August 31).

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (August 31).

LECTURER OF ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, University College, Southampton (August 31).

ASSISTANT LECTURERS (2) IN ZOOLOGY—The Registrar, The University, Manchester 13 (September 1).

EXPERIMENTAL OFFICER (LIBRARIAN) in the War Office—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1574 (September 2).

LECTURER to teach SURVEYING in the Department of Civil Engineering—The Professor of Civil Engineering, Imperial College of Science, London, S.W.7 (September 9).

NATURALIST to develop and supervise the Manx Natural History Department—The Director, Manx Museum, Douglas, Isle of Man (September 15).

LECTURER (Grade IIc) IN THE DEPARTMENT OF BREWING AND INDUSTRIAL FERMENTATION—The Secretary, The University, Edmund Street, Birmingham 3 (September 15).

JOEL CHAIR OF PHYSICS tenable at Middlesex Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 25).

DIRECTOR OF CANCER RESEARCH in the Newcastle Division of the University of Durham (King's College)—The Registrar, University Office, 23 St. Thomas' Street, Newcastle-upon-Tyne 1 (September 30).

SENIOR LECTURER IN ORGANIC CHEMISTRY at the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.569 (September 30).

LECTURER IN DERMATOLOGY—The Registrar, The University, Liverpool (October 1).

CHAIR OF CHEMICAL PATHOLOGY tenable at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 1).

ARCHITECT, a CHEMIST or PHYSICIST, and ENGINEERS (2, civil, mechanical, electrical or chemical), as RESEARCH OFFICERS in the National Building Research Institute of the South African Council for Scientific and Industrial Research—The Scientific Liaison Officer, South Africa House, Trafalgar Square, London, W.C.2.

DEMONSTRATOR IN BIOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1.

JUNIOR LECTURER IN THE BOTANY DEPARTMENT—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh.

BIOCHEMIST to work under the direction of the Honorary Pathologist —The House Governor, Royal Infirmary, Hull.

ASSISTANT LECTURERS (3) IN CHEMISTRY—The Secretary, The University, Edmund Street, Birmingham 3.

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1.

RESEARCH ENGINEER—The Secretary, Gas Research Board, 1 Grosvenor Place, London, S.W.1.

LECTURER ON MECHANICS, THEORY OF STRUCTURES, and PROPERTIES and USES OF MATERIALS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN STRUCTURAL ENGINEERING, at the Constantine Technical College—The Director of Education, Education Office, Woodlands Road, Middlesbrough.

TEACHER OF GEOGRAPHY at the Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

SENIOR ASSISTANT FOR ELECTRICAL ENGINEERING—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institution of Electrical Engineers. Regulations for the Electrical Equipment of Buildings. Eleventh edition. Pp. vi+174. 1s. net. 1946 Supplement. Pp. 18. 6d. net. (London: Institution of Electrical Engineers, 1943–1946.) [252

Manchester Museum: University of Manchester. Report of the Museum Committee for the Year 1944–45. Pp. 18. (Manchester: Manchester Museum, 1946.) 6d. net. [262

Colonial Office. Labour Conditions in East Africa. Report by Major G. St. J. Orde Brown. (Colonial No. 193.) Pp. ii+94. (London: H.M. Stationery Office, 1946.) 2s. net. [13

On Translations: with some Notes on 'Our Universal Language'. By Sir Stanley Unwin. Pp. 8. (London: George Allen and Unwin, Ltd., 1946.) 6d. net. [53

Proceedings of the Royal Philosophical Society of Glasgow. Vol. 70, Part 2: Problems and Possibilities in British West Africa. By Dr. A. B. Trueman. Pp. 13–26. (Glasgow: Royal Philosophical Society of Glasgow, 1945.) [123

Other Countries

Sveriges Geologiska Undersökning. Ser. C, No. 446: Sjösediment och deras bildningsmiljö. Av G. Lundquist. Pp. 31. 1 kr. Ser. C, No. 447: The Telluride-bearing Andalusite-Sericite Rocks of Mångfallberget at Boliden, N. Sweden. By Erland Grip and Olof H. Ödman. Pp. 21. 1 kr. Ser. C, No. 448: Kvartsitskollorna i Ormsjö-Täsjötrakten. Av Torsten Du Rietz. Pp. 38 + 1 plate. 1 kr. Ser. C, No. 449: Stribergs malmfält; geologisk beskrivning. Av Sven Hjelmquist. Pp. 160 + 3 plates. 3 kr. Ser. C, No. 450: Soil Consolidation; Soil-settling Process. By Simon Johansson. Pp. 48. 1 kr. Ser. C, No. 451: Die Foraminiferengattung Gavelinella nov. gen. und die Systematik der Rotaliiformes. Von Fritz Brotzen. Pp. 60 + 1 plate. 2 kr. Ser. C, No. 452: Geology of the Copper Deposit at Laver, N. Sweden. By Olof H. Ödman. Pp. 35 + 2 plates. 1 kr. Ser. C, No. 453: Die Natronreiche Randzone des Granitmassivs nordlich von Smedjebacken in Dalarna; ein Beitrag zum Studium der Granitbildung. Von Sven Hjelmquist. Pp. 34. 1 kr. Ser. C, No. 454: On the Distribution of Metals at Rävliden, Northern Sweden, and in some other Copper-Zinc Ores. By Sven Gavelin. Pp. 34. 1 kr. Ser. C, No. 455: Gränsen ordovicium—silur inom Storsjöområdet i Jämtland. Av Per Thorslund. Pp. 19. 1 kr. Ser. C, No. 456: Zur Kenntnis der alkalinen ultrabasischen Ganggesteine des Kalixgebiets, Nordschweden. Von Walter Larsson. Pp. 41. 1 kr. Ser. C, No. 457: Norrlands jordarter. Av G. Lundquist. Pp. 166 + 2 plates. 3 kr. (Stockholm: P. A. Norstedt and Söner, 1942–1943.) [151

Sveriges Geologiska Undersokning. Ser. C, No. 458; A Graph for the Calculation of the Age of Minerals according to the Lead Method. By Frans E. Wickman. Pp. 6+1 plate. 1 kr. Ser. C, No. 459: Borrningar genom Skånes alunskriffer 1941–42. Av. A. H. Westergård. Pp. 45+3 plates. 3 kr. Ser. C, No. 460: On the Substitution Relations in the Amphibole Group. By Nils Sundius. Pp. 11. 0·50 kr. Ser. C. No. 461: Om jord och vatten på Lanna försöksgård. Av Simon Johansson. Pp. 41. 1 kr. Ser. C, No. 462: Torrsubstanstillgång och vattenhalt i torvmarker i södra Sverige. Av Gunnar Assarsson. Pp. 26 + 1 plate. 1 kr. Ser. C, No. 463: Borrningar genom alunskifferlagnet på Öland och i Östergötland 1943. Av A. H. Westergård. Pp. 22 + 2 plates. 2 kr. Ser. C, No. 464: On Thucholite and Natural Gas from Boliden. By Erland Grip and Olof H. Ödman. Pp. 18. 1 kr. Ser. C, No. 465: De geologiska resultaten fran borrningarna vid Höllviken, Preliminär rapport, Del 1: Kritan. Av F. Brotzen. Pp. 65 + 4 plates. 2 kr. Ser. C, No. 466: Zur Kenntnis der spätglazialen Eisbewegungen westlich des Wenersees, Schweden. Von Walter Larsson. Pp. 13. 1 kr. Ser. C, No. 467: The Alteration of the Rocks in the Copper Deposit at Laver in N. Sweden. By Torsten Du Rietz. Pp. 38. 2 kr. (Stockholm: P. A. Norstedt and Söner, 1944–1945.) [151

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RESEARCH IN THE TEXTILE INDUSTRIES

THE Cotton Board Committee to Enquire into Post-war Problems, under Sir Raymond Streat as chairman, reporting to the President of the Board of Trade in January 1944, gave close attention to research, and urged that the aim of the industry must be to equal and, if possible, surpass the achievements of all rival textile industries. It recognized that, although the Government could do much to encourage research, the outlook and actions of those concerned in the industry would dictate the ultimate results in this field, and that the employment in development of men of real scientific attainments would be a factor of special importance in the period of exceptional technical development which the Committee anticipated. The post-war Cotton Board should, in the opinion of the Committee, do everything in its power to further research and to assist every unit in the industry to secure the fullest access to its fruits.

The Cotton Board Committee appended to its report a memorandum on scientific and technical research, in which it reviewed the growth of research in the industry during the last twenty-five years and the present position of the industry's research association as well as the needs of the future. The Committee in this memorandum emphasized the profound importance to the future of the industry of the fundamental scientific research work of the Shirley Institute, and expressed the emphatic opinion that the Institute should continue to interest itself in all fibres likely to be of use to the Lancashire industry. Tribute was also paid to the liaison work and training scheme of the Institute, and hope was expressed that the highest possible degree of priority would be given to the intensification of these activities in the reconstruction period. Thorough investigation of problems connected with consumer research by a suitably constituted committee of the industry was also recommended.

Neither these recommendations and the memorandum embodying them, nor the accompanying memorandum on economic research and information, appear to have received the attention from the cotton industry or from scientific workers themselves that was hoped. Nevertheless, it is clear that the chapter on science and industrial progress in the report of the Cotton Working Party* owes much to this earlier memorandum, although the recommendation relating to market research passes over the suggestion in the previous memorandum regarding the need for statutory powers to collect information, and authority for the post-war Cotton Board to spend a reasonable sum on economic research and in collecting and circulating information. This chapter and the ensuing recommendations, however, have claims on the attention of industry and of scientific workers generally. Much of the soundest opinion expressed in the discussion on scientific and industrial research is reflected in this report ; it avoids platitudes, and outlines a pro-

* Board of Trade. Working Party Reports : Cotton. Pp. vi+278. (London : H.M. Stationery Office, 1946.) 3s. 6d. net.

gramme which British industry generally and also the universities would do well to mark.

Much would indeed be expected from the Research Sub-Committee, which included Mr. J. Baddiley, Prof. Willis Jackson and Prof. W. E. Morton, on whose reports and data the Working Party based its findings. It is unfortunate that this valuable section of the report—an outstanding contribution to the development of industrial research—should have been so overshadowed by the more controversial sections as to pass virtually unnoticed by the scientific and technical Press. This lucid exposition of the relations between industry and science indeed well merits issue as a separate document; moreover, unlike other sections of the report, it is endorsed without reservations by the whole Working Party.

Research is classified into three types: fundamental research, or the pursuit of knowledge for its own sake; operational research, or the use of scientific method in the study of practical industrial problems; and applied research, or the application of scientific knowledge to the improvement of industrial production or practice. Only the first and third of these are regarded as covering activities generally understood as scientific research. Operational research may involve activities of an entirely different nature, such as market research and labour research, or investigations in the wide field represented by the expression 'industrial relations'. Elsewhere, the Working Party recommends that a programme of research on matters affecting industrial employment should be worked out by the central body for the industry, and emphasized the need for scientific study in questions affecting the human factor. Apart from this, however, operational research and applied scientific research often overlap, and no hard-and-fast line can be drawn, so that some of these activities can appropriately be handled by an organisation set up to deal with scientific research.

Reviewing next the characteristics and conditions of the cotton industry, the report points out that, apart from the unification of outlook on the textile fibres resulting from recent fundamental research, the development of synthetic fibres has had important reactions on the industrial position. The spinners and weavers are in effect being sandwiched between an essentially chemical industry at one end making the raw material, and at the other end a chemical industry making the finishing materials. There is evidence that these scientific industries will not be content to accept the traditional methods of spinning and weaving, and, still more important, they are concerned with the whole field of textile industry. The four separate textile industries of the past—cotton, wool, flax and silk—must, if they are to be progressive, make use of the new fibres and introduce spinning and weaving materials adapted to it. To a large extent the new problems arising will be common to all four and the new knowledge will cut across all their dividing lines.

From this introductory survey the Working Party stresses some important points which apply to other industries as well as the textile industries. The need for a widely interpreted reciprocal relation between industry and science, and the importance of having sufficient men of high ability to carry out the necessary scientific investigations, have been emphasized in more than one report in the last few years. Less frequently, however, has it been recognized that science cannot make its true contribution to industrial progress unless research workers create an organised body of knowledge relating scientific theory with industrial practice, and unless industry, on its side, has enough men on the administrative side capable of understanding scientific principles. These are however, two of the main factors which should determine the strategy of research, and the points made more particularly regarding the critical nature of the present moment for the textile industry and the great opportunity before it serve to underline their importance.

The admirable summary of the extent and scope of research work within the cotton textile industry both at the present time and during the last twenty-five years is of exceptional interest to the scientific worker. Moreover, it is noted that many of the developments are international in character, coming from scientific workers in many countries. While the share of British men of science in the past has been a notable one, the Working Party considers that in view of the rapid increase in scientific research and in higher education throughout the world, special efforts are now required to encourage and foster research activities in Britain to enable the country to maintain its position in the face of the intense industrial competition now to be expected. In particular, the Working Party endorses the view of the British Rayon Federation that the existence of a central rayon research institute in no way absolves individual firms from maintaining their own internal research organisations, which, on the contrary, it should supplement. This view is urged as equally applicable to the cotton industry, and in particular the Working Party considers that the textile machinery makers need to increase the scope of their research activities.

That is only one point on which the Working Party is highly critical of the industry. Urging the closest possible collaboration between the textile machinery industry and the centres of fundamental research, it points out that the textile machinery industry must not sit passively waiting for ideas on the physical properties of fibres to be passed on to it by the fundamental research centres. It should have a contribution of its own to make, and above all should employ a sufficient number of able physicists competent to understand the significance of fundamental discoveries and ensure that they are utilized and developed. It is noted that there are firms still hostile to the idea that higher education in general and higher scientific education in particular are of value in business. Apart from the finishing section of the industry, where the day-to-day operations are more nearly scientific than technological, research within the industry appears, with notable exceptions, to be directed mainly towards the refinement and

improvement of existing machines and processes, rather than to discovery or invention of fundamentally different ones.

The Working Party's observations on long-distance prospects of the technical development as well as on the liaison between centres of research activity also deserve consideration, both outside and within the cotton industry. The comment that the development of new fibres has possibilities which require the intensive and constant attention of the designers of textile machinery is obviously of interest chiefly to the textile industries; but the observation that liaison between the various research groups in the cotton textile industry could be very materially aided by the professional and scientific organisations, such as the Textile Institute and the Society of Dyers and Colourists, has wide implications for industry generally as well as for the scientific societies. The Working Party considers that the work of these two societies should be encouraged and assisted by the cotton industry, while it hopes that the Manchester Joint Research Council may also provide real assistance to the industry and that its facilities will be utilized to the full, along with those of the professional institutions and scientific societies, particularly in making surveys and reviews of textile knowledge and in organising conferences on textile problems from which suggestions for further investigations may come. Incidentally, it should be noted that in connexion with the employment in the industry of more people with a scientific training and outlook and improving the quality of the personnel in marketing, Prof. Jewkes refers to the great shortage of good text-books on textile matters, and suggests that the possibility of financing the production of these is worth the attention of the Cotton Board.

Thus far the report has considered the effective functioning of the trade research associations and the research activities of individual firms, incidentally paying a very high tribute to the work of past and present men of science in the laboratories of some firms. It then turns to consider the functioning of a further main instrument of research—the universities and technical colleges. Here the Working Party proceeds to press the argument for university expansion. Every endeavour should be made to enable the universities to train a larger number of students, and it has endeavoured to make some estimates of the industry's requirements of graduates both in textile technology and in pure science over the next five years.

While, however, the Working Party recognizes clearly the twin functions of the universities of giving training in fundamental science and of carrying out unfettered academic research, it does not look to the universities merely to train in research methods the men who will later on occupy research posts in industry. It is concerned at the tendency of firms which recruit scientific workers to regard them merely as experts who are to be confined to rendering a limited subsidiary service. That view has been repeatedly repudiated in recent authoritative reports, and the Working Party is emphatic that the cotton industry will not appreciate the value of scientific method or realize the commercial value of new scientific ideas if all trained scientific employees are confined to this role; and like the Cambridge University Appointments Board Committee on University Education and Business it points to the adverse effect on the attractiveness of a scientific career of such a limited conception.

The conclusions of the report in regard to the supply of qualified men merit careful attention in the formulation of plans for university expansion. The cotton textile industry, it is held, should encourage and assist financially and otherwise the maintenance, in universities and other teaching institutions of university rank, of strong and active research schools dealing with textile science and technology and the fundamental scientific background of the textile industries. As examples of the importance of scientific research in British universities to the industry, the report cites the work carried out on the structure of carbohydrates, which has revolutionized our knowledge of the structure of the fundamental materials used in the cotton industry and in other industries, and the fundamental scientific investigations on materials of interest to the cotton and rayon industry at present being developed in the laboratories of the University of Manchester for open publication. The Working Party is of the opinion that a strong school of textile technology and textile science should be maintained in Manchester, and that it should be assisted and encouraged in every possible way to undertake both the training of graduates and the carrying out of fundamental research in the various branches of textile science.

Important as is this contribution of the universities in fundamental research, and desirable as it is that firms in the industry should be given every encouragement to make contacts with the research schools for their mutual benefit, the Working Party emphasizes very strongly the need for the universities to maintain complete freedom as to the scope and direction of such fundamental research in their laboratories. Unless such work is spontaneous and unfettered, and its results open for full and free discussion, the progress of scientific discovery will be retarded and hindered. The value of personal contacts for discussion and exchange of information is again emphasized here, as in relation to the scientific and professional societies. The Working Party and its research sub-committee have clearly recognized the value of free dissemination of information in stimulating ideas and promoting the advance of industry as well as of science. Once again we find a policy of encouraging publication advocated, and the establishment of industrial research fellowships and associateships is suggested, a plan for which is sketched in the final recommendations. On the other hand, the Working Party is on much more dubious ground, and at issue with the Barlow Report on Scientific Man-power and the latest statement of the Ministry of Labour regarding military service, in suggesting that genuine training within the universities in textile science and related branches of pure science should be

regarded as a form of national service. If restrictions are to be relaxed and exceptions made to a general policy, it must be on national grounds and not for the advantage of a particular industry, no matter how important.

In view of the unification of textile science resulting from scientific progress during the last twenty-five years, it is considered that a co-ordinating body is required such as a Textile Advisory Research Council, covering the entire field of textiles, which could act in an advisory capacity to review, expand and co-ordinate research and development throughout the textile industries. Detailed proposals for the aims, functions and composition of such a council are appended to the report, and represent a contribution to the formulation of the broad strategy of textile research in Britain which is worth consideration as a general principle as well as from the particular point of view of the textile industries.

Such an advisory council, the Working Party suggests, would facilitate the correlation between the work of the central research institutions and the work of individual firms. The precise nature and scope of the functions of the research associations, how they can best be exercised, by what means their functions can be made of the fullest possible value to the industry, and how they should be correlated with the work of the research departments of individual firms are questions which confront research associations in all industries, and the Working Party does not think that the right answers to these questions are yet clear. It suggests that a review of the experience of the whole of the research associations in Britain would be useful.

As in other industries, there is clear need for better, and in particular speedier, methods of translating research results to large-scale production, and the greatest immediate practical need for British industry is to secure more effective application of scientific knowledge in industrial practice. Many of the proposals already noted are directed to that end, and in particular the increase of the proportion of men with good scientific training in the employment of industry. Only when the industry learns to use such men rightly, and when they are distributed sufficiently widely through the industry, can the dissemination of information by publication or by conferences, for example, be fully effective. Such conferences might be arranged for different classes of people at different times, for example, for directors, managers and foremen; and the Working Party suggests that a higher degree of integration or grouping together of the smaller firms may also assist in the absorption in the industry of more graduates in science.

The major interest of the report to the scientific worker is this outline of research strategy, set forth in a manner which, while applied in the first instance to the cotton and textile industries, is such that, quite apart from the general validity of its principles, it could easily be integrated with the general research structure and policy of Great Britain. It will be noted, moreover, that the Working Party avoided entering on a debate as to the extent to which research can be planned; this may be attributed to the clear conception of objectives and to the discrimination between different broad types of research.

While the particular section of the report we have been considering is concerned with scientific research in the limited sense already indicated, other sections of the report contain recommendations for research in other fields. For example, the need for scientific study in the field of human relations is emphasized. In this connexion the Working Party is concerned not only with research on matters affecting the physical health of the workers but also with the scientific study of conditions affecting the work-load involved in various processes, psychological factors, etc. It considers that a special intensive programme of study under these headings should be worked out by the central body for the industry. Again, in regard to market research, it points out that if this is to be valuable it cannot be conducted in a piecemeal or desultory way. The surveys involved require skilled personnel and must be undertaken continuously and on a broad basis. There is a great shortage of personnel with the requisite training. Substantial expenditure will be required to build up a staff and conduct work on an adequate scale, and there must be determination to go through with the task even if it does not show any immediate return. The Working Party recommends that the sum of about £350,000 now held by the Board of Trade, representing the unexpended balance of funds raised by levies in the first period of the operation of British Overseas Cotton Ltd., should be used to finance a programme of market research specially directed to the development of export markets.

Though there is much in the report of only indirect interest to scientific workers as such, it should be clear from what has already been noted that the report is addressed to the attention of many far outside the cotton industry itself. It is not merely that the Working Party considers that the integrating force which scientific advance has created for all the textile industries necessitates a new outlook on the relations between them; and accordingly it recommends that the Government should call an early conference between representatives of the rayon industry and all the textile industries to consider their future relations. Equally, in view of the importance of relating knowledge gained from research into potential market outlets with the industry's productive capacity, it suggests that special arrangements should now be made for organised consultation between the producing sections and those who have a close knowledge of consumer requirements, including large consuming institutions and representatives of scientific organisations such as the Shirley Institute, the proposed British Rayon Research Association, the British Standards Institution and the British Launderers' Research Association.

The organisation of such systematic conferences would do more than build up a body of knowledge and a method of co-operation which can be of the greatest value to the industry. It would equally facilitate a much wider understanding of the problems

of the cotton industry and of the textile industries generally, and encourage the contacts which might accelerate the breakdown of some of the older prejudices of the industry and encourage the wider use of trained men of science and a more scientific outlook at all levels. The report does indeed glance at the question of training for management, and in a section under that heading, besides recommending the long-term policy already noted of making special efforts to bring in, on the management side, men with high scientific or technical qualifications, it suggests that a larger proportion of young men is required in leading positions, and that it would be advantageous to bring in men with experience of modern methods as developed in other British industries.

The Platt Mission's recommendation that more facilities should be given for young men undergoing full-time college training in textiles to spend their vacations in mills is endorsed in this section of the report, where it is also recognized that more systematic arrangements are required for training in the principles of management and for broadening the outlook on administrative problems of those holding positions of responsibility. But while the Working Party welcomes the Government promise of support for a British Institute of Management, which it believes would be of value to the industry and should claim the support of the cotton industry, the suggestion that Lancashire should promote its own staff college is, to say the least, dubious. Leaving out of account the mere technical aspects of operating and organising of the industry, on which the Working Party itself is divided, the section on scientific and industrial progress to which all its members have subscribed constitutes a grave indictment of a large section of the industry, which is not disguised by the moderation of the report or its well-deserved tributes to the past achievements of individual British men of science and firms. Whatever may be the causes for this neglect and failure in the past, one factor, as the Working Party recognizes, is the isolation from which the cotton industry has generally suffered. What is needed now is to bring together men and women of executive responsibility from industry and commerce, the trade unions and central and local government, to study the common principles that underlie effective administration. To limit such a movement to Lancashire and to the cotton industry only would be to lose an invaluable opportunity to which this report directs attention anew. On the merits of many of the proposals of the report it is not for the man of science as such to pronounce. He can at least recognize the value of the contribution to the development of an adequate strategy and theory of research to be found in this report, endorse the appeal of the Working Party for the impartial study by the many interests concerned of this appreciation of the problems, and play his own part in urging the education and co-operation which are essential. Both are imperative to place this great industry on a basis which will enable it to utilize to the full the great opportunities which scientific and technical advances have already brought to its door.

CANCER RESEARCH IN THE UNITED STATES

A.A.A.S. Research Conference on Cancer

A Conference of Papers and Discussions presented at the Summer Meeting of the Section on Chemistry of the American Association for the Advancement of Science at Gibson Island, Maryland, July 31–August 4, 1944. Edited by Forest Ray Moulton. Pp. x + 333. (Washington, D.C.: American Association for the Advancement of Science, 1945.)

Like other peaceful pursuits of science, cancer research has probably been less interrupted during the war years in the United States than in Europe, and the publication of the papers and discussions at the American Association for the Advancement of Science Research Conference on Cancer held in 1944 is particularly valuable to non-American readers as "A landmark that records in some measure the status of cancer research in 1944", to quote from the introductory remarks of the chairman of the Conference, Dr. Dean Burk. In fact, the contents do seem almost fully up to date, partly no doubt because post-conference amendments and additions have been permitted to the participants. A judicious combination of this privilege with verbatim reporting by the new stenotypic method has resulted in a lively and informal record, especially in the discussions of the various papers presented, and the volume is a worthy successor to the earlier publication of the Association —"Some Fundamental Aspects of the Cancer Problem", which appeared in 1936.

Although inaugurated by the Chemical Section of the Association, the scope is wide, not restricted to chemical aspects but covering also almost the whole field of laboratory cancer research. The virus approach, carcinogenesis, enzymes, diet, and chemotherapy, form the main sub-divisions, each of which contains at least one first-class contribution, and often many more. For example, the 106 pages on the virus aspects, still perhaps the most controversial and provocative corner of the cancer field, contain a full introductory review by F. Duran-Reynals and W. Shrigley, of Yale, in which after dealing with the historical associations, the authors frankly "review certain facts that we know about cancer and . . . show that the properties of viruses and virus infections fit these facts very well". As would be expected, these views have their supporters and opposers in the ensuing discussion; L. C. Strong considers as a geneticist that the inexhaustible capabilities of cell differentiation reduce the cancer problem to the rank of a very minor biological matter, while the virus concept "entirely shoves aside" the whole field of embryology and differentiation. M. B. Shimkin is also critical of the wide extrapolation of observations made on the relatively few virus-induced tumours to the whole range of cancer, including that occurring in species in which no such viruses have been demonstrated as the causative agent; cancer may rather be "the end product of multiple etiological agents and multiple chains of reactions all leading to a somewhat similar terminal stage". A. Taylor and his colleagues believe that they have shown the presence of "extracellular tumour agent", as they call the "virus", in mammary cancer of mice by growing the tissue in yolk sac of hens' eggs and preparing from the eggs Berkefeld filtrates and dried material which have given malignant tumours when injected into mice. These results, like others from cultures of mouse

tumours in the anterior chamber of rat's eye, are evidently not yet accepted as proved by many of the participants, who ask for much clearer proof that such extracts were really cell-free; negative results with similar material are reported by W. R. Bryan, H. Kahler and V. T. Riley as the outcome of a careful study. They found no evidence of the presence of a rapidly acting virus-like principle associated with the Jensen rat sarcoma, the S37 mouse sarcoma, or the Taylor mammary gland carcinoma.

About half the section on viruses is devoted to the mammary tumour inciter which was first shown by Bittner in 1936 to be present in the milk of mice, and to produce, in an otherwise suitable strain of mice, a greatly increased incidence of mammary cancer. Few will quarrel with M. B. Shimkin and H. B. Andervont's statement that this discovery "represents probably the most significant advance in cancer research during the past decade". It is therefore a particularly valuable feature of this book that it includes a masterly review of 38 pp. by J. J. Bittner and important contributions by Shimkin and Andervont to this subject. At the present time three inciting influences are recognized in the etiology of spontaneous mammary cancer in mice: the inherited susceptibility, the hormonal stimulation, and the agent transferred in the mother's milk. The last is present in the first milk and throughout the period of lactation. It has been recovered from lactating mammary tissue, spleen and thymus, heart and lung, spontaneous mammary carcinoma, mammary cancer which had been transplanted for ten passages in mice not possessing the milk agent, and it may be present in the blood either within the blood cells or adsorbed on to them. The agent may be transferred by injection or feeding; it remains active after desiccation, filtration through Berkefeld or Seitz filters, lyophilization, or treatment with glycerol, petroleum or acetone. Its activity is destroyed by exposure to 60° or by acidity below *p*H 4·5; between *p*H 5 and 10·2 it is stable at ordinary temperature. It appears likely that in order that mice will develop 'spontaneous' tumours they must be exposed to the agent before their mammary glands have developed; but although mice so treated may themselves remain non-cancerous, they may transfer the active agent to their progeny, which may then show a high incidence of spontaneous mammary cancer. It is not yet known whether a similar agent is present in any species other than the mouse, including humans, and some evidence seems to oppose the view that it is. Apparently the rabbit can produce an antibody to the milk factor (M. B. Shimkin), and confirmation of this is forthcoming in papers published since the Conference (R. G. Green; R. G. Green, M. M. Moosey and J. J. Bittner, *Proc. Soc. Exp. Biol. Med.*, **61**, 113; 115; 1946). Ultracentrifugal studies suggest that a particulate material of sedimentation velocity about 60 S, containing ribonucleoprotein, may be the agent or contain it. The book provides an admirable account of these striking advances up to 1944.

An interesting question arises in the relationship of the milk factor to chemical and other carcinogens. Methylcholanthrene has been found to induce mammary cancer in strains devoid of the milk factor (M. B. Shimkin and H. B. Andervont, this volume p. 103; see also A. Kirschbaum, W. L. Williams and J. J. Bittner, *Cancer Res.*, **6**, 354; 1946). Stimulation by œstrogens, which itself does not result in cancer in absence of either the milk agent or the carcinogen, seems to be a necessary concomitant for carcinogenesis of this kind. Thus to some extent the chemical carcinogen can supplant the milk factor, an observation that opens up an attractive field for future investigations. L. F. Fieser, in a brief but stimulating article, reviews hydrocarbon carcinogenesis from the point of view of the organic chemist. Other valuable articles include several on leucæmia, on the production of malignancy *in vitro*, and of enzymes in normal and neoplastic tissues; in fact the book as a whole will be found to be a highly readable and informative account of current trends in cancer research in the United States.

There are those who affect to view such symposia as this as superfluous, on the grounds that they are mainly either recapitulations of work already published, or premature anticipations of that not yet ready to appear in public; but probably the majority will, like the reviewer, be grateful for the saving of time and effort afforded, especially now when our libraries have not yet fully recovered from direct and indirect effects of war. F. DICKENS

A TEXT-BOOK OF GLACIOLOGY

Gletscherkunde

Von Dr. E. von Drygalski und Dr. F. Machatschek. Pp. 250. (Vienna: Franz Dentike, 1942.)

IF only on account of its rarity, the publication of a text-book of glaciology is an event worth noting, especially when the book bears the name of so famous an explorer as Drygalski. This book is written primarily for the student of physical geography, but it will interest all scientific men and laymen who have studied glaciers and have attempted to solve some of the fascinating and paradoxical problems which their behaviour so often presents. The comprehensive contents touch all aspects of glaciology, from the physics of glacier flow to the climatological implications of recent changes of glaciation.

A historical introduction is followed by three chapters devoted to more elementary topics: the definition of the snow line, the classification of glacier types, and glacier economy. A descriptive section on avalanches is appended to the first chapter, but contains little reference to the fundamental work on that subject which was recently done in Switzerland. The chapter on glacier economy gives a clear and balanced account of the different factors affecting accumulation and ablation, and of the difficulties which their exact estimation involves; descriptions of "Büsserschnee" and other unusual effects of ablation are also included, though the explanations of their origin could have been made clearer with the help of illustrations. The scarcity of these is felt throughout the book, and particularly in the chapters on the physics of ice and the structure of glaciers. The general standard of these two chapters falls a little behind that of the rest, partly because the authors treat the plasticity of ice as an isolated phenomenon, while it is surely but one aspect of the mechanical behaviour of polycrystalline materials in general.

The sections on ice stratification and banding in glaciers are somewhat obscure, and fail to dispel the mist of confusion in which that subject is still, perhaps rather unnecessarily, shrouded. Apart from these minor defects, the chapter on glacier structure and the succeeding one on glacier flow are well balanced, since the authors steer clear of all the exclusive theories of glacier flow which have caused

such heated controversies in the past; they succeed in representing glacier flow as a complex and composite phenomenon which is still far from being completely understood. The chapter on moraines which follows is one of the best.

The book derives its main strength from the authors' own remarkably wide experience of glaciers in all parts of the world. One would naturally expect two Munich professors to concentrate on data collected from the Alps. Instead, the glaciers of Greenland and Spitsbergen, the Antarctic and the mountain chains of Central Asia are all treated with familiarity and competence. This world outlook not only adds interest to a long chapter on the geographical distribution of glaciers, but also impresses on the reader the immense variety of glacier forms and behaviour, and cautions him lest he should draw too wide generalizations from his own limited experience in one particular part of the world. The last chapter deals with glacier variations, and contains a wealth of information concerning the changes of landscape and climate which have accompanied the advance and recession of glaciers in historical times. The authors are at pains to demonstrate the limitations of various theories of climatic cycles and to show that glaciological data provide no support for their existence. The rapid recession of glaciers in all parts of the world since about 1850 must fill the reader with alarm, lest glaciology become a science of the past before the manifold forms and processes exhibited by these great ice-streams have been properly understood.

The references in the book to the literature of glaciology are extraordinarily complete, though their arrangement might have been improved; there is no index of authors and the subject index is far from adequate; the shortage of illustrations has already been mentioned. Some of these failings may have been due to war conditions, yet it is a pity that they should detract from the usefulness of an otherwise admirable text-book.

M. F. PERUTZ

THE DOCTORS' DIAGNOSIS

A Charter for Health

By a Committee of the British Medical Association under the Chairmanship of Sir John Boyd Orr. Pp. 96 + 18 plates. (London: George Allen and Unwin, Ltd., 1946.) 6*s.* net.

THIS attractively produced little volume, with its well-chosen photographs and simple coloured graphs of vital statistics, is clearly directed towards the intelligent general public (although one suspects that the rather high price may reduce its circulation considerably) and gives a simple, clear and authoritative statement of the factors affecting the health of the individual and the community. In the words of the final chapter, "The doctors collectively have in the preceding chapters attempted to diagnose the nation's condition", and their attempt has been very successful. The further claim to "have given a prescription to guide the community" could, however, scarcely be substantiated, and this for the very good reason that medical practitioners as such have no greater skill in political prescription than politicians have in medical. In a way, the committee of authors recognizes this, for the preface informs us that "Controversial issues have been avoided"—and what more controversial than politics? Within this self-imposed limitation, however, the Committee has done an excellent piece of work.

Beginning with a forward-looking statement on the role of medicine through which the conception of 'positive health' runs and in which some recent advances in medicine are surveyed, the book proceeds to consider preventable disease and adduces statistics of unnecessary morbidity which cry aloud the need for immediate action. Then come chapters on the family and the home which follow the views of most competent authorities, and contain recommendations which, if implemented, would materially benefit the physical and mental health of our citizens. A chapter on food points out the need for government action in improving the nutrition of our people, and indicates the path as clearly as any book intent on avoiding controversial issues could do; while chapters on occupation and recreation balance the needs of work and leisure. Mental health is the next subject, which is covered as adequately as so many topics as emotional security, habit formation, preparation of children for the arrival of a new baby, delinquency, sex education, adolescence and marriage can be in some seven pages in all. The next chapter, on health education, puts forward some concrete suggestions on the content and method appropriate to particular ages, and is followed by some statistics of mortality and morbidity which provide excellent ammunition for fighters for a 'new deal' in health.

The book thus covers an extraordinarily wide field in small compass, and it would be quite unfair to criticize it on the grounds of superficiality. There are, however, some respects in which criticism is valid. The language is sometimes verbose ("The improvement of health and the prevention of disease should progress together. All the weapons which serve this purpose should be used simultaneously and advantage should be taken of all the means which medical science increasingly affords and medical research may hereafter disclose"), occasionally platitudinous ("The child's place in school should be suited to his capacity, neither above it nor below it"), in places somewhat technical ("a survival from the arboreal habits of anthropoid ancestors in forests infested with prowling carnivora of nocturnal habits") and in at least one sentence open to double interpretation ("Many still-births and premature births are due in large measure to the malnutrition of the mother or her employment in arduous labour towards the end of pregnancy"!). The Committee, moreover, in its statement that "Only very recently has any headway been made, mainly due to the work of the Central Council for Health Education, in breaking down public prejudice" against venereal diseases, is less than fair to the valuable pioneer work of the British Social Hygiene Council in this field.

One other point of criticism is that the Committee (consisting almost entirely of men) does not seem to appreciate fully how valuable a part a well-trained husband can play in home and family life. Why, for example, should the education of girls be "designed to teach them the art of home-making" and not that of boys? Why should the mother represent the "background of the home" and the father "all the outward striving away from the home"? And, while on this topic of the respective roles of the two parents, is it not rather surprising to read that "The mother's occupation is . . . above all, to bring children into the world"? Shades of 'kids, kirk and kitchen'!

But when all criticism is made, this book remains a most useful piece of work, and the British Medical Association Committee is to be congratulated on it.

CYRIL BIBBY

A LARGE ASTRONOMICAL TELESCOPE FOR GREAT BRITAIN

A DISCUSSION on the use of a large telescope in Britain took place at a meeting of the Royal Astronomical Society on June 14. This discussion had its origin in the presidential address delivered to the Society earlier in the year by Prof. H. H. Plaskett, who pointed out that, lacking a telescope of large light-gathering power, British contributions to a large part of observational astronomy would of necessity become practically negligible. He also emphasized the interrelation between observational and theoretical work, and reminded the Society how in the past the advance of physics has depended upon observational discoveries in astronomy. He put forward suggestions for the construction of an instrument of the Schmidt type with a mirror of 74 in. aperture, suitable both for direct photography and for slit spectroscopy. The estimated cost of such an instrument, with proper ancillary equipment, is £100,000, and Prof. Plaskett suggested that the Society should take the initiative in making application for the necessary capital cost and running expenses, the idea being that the equipment should be installed at a suitable central site and should be available for use by all the observatories in the United Kingdom.

During the four months following Prof. Plaskett's address, British astronomers gave his proposal active consideration, and a crowded meeting at Burlington House on June 14 heard the scheme fully and freely discussed. In the absence abroad of the Astronomer Royal, Sir Harold Spencer Jones, his opening contribution on observing conditions in Great Britain was read by Dr. R. d'E. Atkinson. Sir Harold pointed out that estimates of night cloudiness at a particular site must, in the absence of direct data, be made by rather roundabout methods. At Greenwich, night sky records have been made by obtaining trails of circumpolar stars with a fixed camera, and there is a general positive correlation between the yearly totals of clear sky obtained from these records and the annual sunshine totals. Sunshine records indicate that the south-east is the most suitable region in England for astronomical observations. On the basis of the sunshine records for Herstmonceux Castle (the new site chosen for the Royal Greenwich Observatory), Sir Harold predicted that for this site 1,500 hours of clear dark sky should be obtained in an average year.

The question before us, then, is whether this total of 1,500 hours is enough to justify the installation of a large telescope. Sir Harold pointed out that only a small fraction of the astronomer's time is spent in actual telescope work. For most observations by far the larger part of the total work is taken up by plate measurement, reduction of the measures and analysis of the raw material thus obtained. For a long-term, fairly routine programme, such as stellar parallax work, the ratio of observing to non-observing time is found by experience to be about 1 to 8. In such work only a few stars are measured on each plate; but for positional work, such as zone photography with a wide-angle lens, hundreds of stars are measured on a single plate, and heavy computations are involved; for this work the ratio may reach 1 to 700. Between these two extremes lie ratios applicable to other programmes, and as a rough average the office time required can be put down as a hundred times the observing time. With this ratio, an annual total of 1,500 hours observing time would keep a considerable number of astronomers fully occupied, a conclusion which is confirmed by experience with the 72-in. reflector at Victoria, B.C., where the annual total of clear night sky is less than 1,500 hours. From the magnificent results obtained there on a variety of well-planned programmes, Sir Harold deduced that the installation of a large telescope in southern England would be fully justified. This conclusion was of great interest to the meeting, since some rather defeatist statements have been made in the past to the effect that the British climate is such that no adequate return can be expected from the erection of a large telescope.

The discussion was continued by Prof. W. M. H. Greaves, Astronomer Royal for Scotland, who said that it was his task to outline the programmes for which the proposed new equipment could be used. He proposed to fulfil this task by asking a rather wider question: What contributions can British astronomers make to the major problems of astronomy, given the requisite equipment? Refusing to subscribe to the view that we should be solely concerned with the provision of a large telescope in Great Britain, he said that the major problems demand observational material from both hemispheres, and in the present state of the world it is largely for the countries of the northern hemisphere to make adequate provision for work in southern latitudes. British astronomers cannot escape their responsibilities in this direction, especially as the British Commonwealth includes southern countries with good climatic conditions. How, then, are our responsibilities being met as regards the major problems of astronomy, and what can be done given the proposed new equipment?

One major research is the study of the structure and dynamics of the galaxy, and this requires photometric work combined with good proper motions, parallaxes and radial velocities. As regards proper motions and parallaxes, we are already playing our part, and we can be confident that the Greenwich and Cape Observatories would see to it that we continue to do so. As regards radial velocity work, the proposed programme with the 74-inch telescope at the Radcliffe Observatory, Pretoria, will complete the magnificent work done in the northern hemisphere at Victoria, and the two series will constitute an achievement of which British astronomers can be proud. But galactic research is primarily based on photometric work; the main observational raw material consists of counts of stars down to assigned apparent magnitudes in various fields of the sky, and the evaluation of the absorption of light by interstellar material is a photometric problem. The necessary photometric programmes consist of (*a*) a large-scale survey of areas distributed over the whole sky, which would lead to a general smoothed picture of the galactic system; and (*b*) a more detailed survey based on the study of areas selected for the enhanced presence or absence of obscuring material. It is essential that the photometry should be of first-class quality; there is no room in this research for poor quality mass-production.

The British contribution to this very important photometric work is, to our shame, practically zero at present. As regards (*a*), the Mount Wilson survey can be said to have met the immediate requirements in the northern hemisphere, but there remains (*b*), where we could play an important part if we had a

large telescope of the Schmidt type. When we come to consider the state of the southern hemisphere work, the sad fact emerges that, so far as photometry of precision is concerned, astronomy has practically the whole way to go in both (*a*) and (*b*). Here is a chance for redeeming our past neglect in one of the major problems of astronomy. Prof. Greaves believes that in determining our contribution we should give priority to the erection of a Schmidt telescope in the southern hemisphere, to be operated by British astronomers. But northern work is very important; we should play our part by erecting a large Schmidt telescope in Great Britain as well.

Another major problem is the study of the physics of individual stars and other celestial objects. In this comparatively young and rapidly developing subject, the main observational weapon is the spectroscope. But to obtain spectra of reasonable dispersion, one must feed the spectroscope with sufficient light, and at present we are not playing our part mainly because our instruments are too small. By the imminent erection of the 74-in. reflector with spectroscope at Pretoria we could claim that we are playing our part in southern work, but observations in both hemispheres are necessary. To maintain the necessary close association of astrophysics with the main body of physical science under present conditions, we must push on with observational astrophysics, including the development of new methods, in Great Britain. But the tendency for clear sky to occur in comparatively short spells in the British Isles is emphatically against any programme involving long exposures, and to obtain material of real value a large telescope is a necessity. Prof. Greaves commented that if anyone wished to carry out any particular astrophysical programme in both hemispheres, and if he only had funds for, say, a 72-in. and a 36-in. reflector, then common sense would dictate that the larger instrument should be erected in Britain, and the smaller in a country like South Africa where the climate is suitable for long-exposure work. The two parts of the programme would then keep in step. As it is, unless the proposed equipment is forthcoming, he believes that we in Great Britain will lag behind in observational astrophysics. There is plenty of work to be done, but a large telescope is a necessity if we are to take part in it.

With regard to the cosmological study of the universe of galaxies, which constitutes a third major research, Prof. Greaves said that at present we are contributing precisely nothing. Good photometry can discriminate between some of the rival hypotheses that have been advanced, but so far the very valuable pioneer work that has been done does not come up to the requisite standard of photometric precision; given a large Schmidt instrument we could play a notable part. He concluded by saying that in all three of the major problems considered, we could contribute materially given the necessary equipment, but that without such equipment our contributions would remain practically ineffective and British observational astronomy would slowly die. The connexion between observational and theoretical astronomy is so intimate that the latter could not long survive the death of the former; and the death of British astronomy could only inflict harm on the main body of physical science.

The meeting then considered details of the proposed instrument. Mr. F. J. Hargreaves dealt with the mechanical problems involved in the design of a large telescope. Not all mountings, as he pointed out, allow all parts of the sky to be reached, and the fact that the mirror alone of a 72-in. reflector would weigh about two tons means that the engineer is set many problems in avoiding flexure. With the aid of diagrams, Mr. Hargreaves described the two main classes of mounting: the 'overhung' type, in which a declination axis, set at right angles to the polar axis (about which the instrument turns), carries the main tube at one end balanced by a counterweight at the other; and the 'trunnion' type, in which the tube is slung within the polar axis and is thus supported from both sides, a counterpoise being unnecessary. Each has its advantages and drawbacks, and Mr. Hargreaves described some possible ways of combining the good points of each without their disadvantages.

A desirable feature of a modern telescope, incorporated in the new 74-in. Radcliffe reflector, is an optical laboratory, below the dome floor, into which the light is directed by auxiliary reflectors. This avoids the need for carrying heavy or awkwardly shaped apparatus on the telescope itself, and enables the observer to work in comfort in controllable conditions. With the overhung construction modified as at Pretoria, this can be achieved with only two additional reflexions, but with the conventional trunnion mounting four are needed. Mr. Hargreaves suggested a modification of his own which eliminates two of these, and concluded by showing how this could be combined with many of the good mechanical features of other existing mountings to give a design for the proposed new telescope which could be both mechanically sound and optically efficient.

In a contribution concerned entirely with arriving at the most desirable optical train for the telescope, Dr. E. H. Linfoot pointed out that the classical Cassegrain can scarcely be bettered as a condensing system for stellar spectroscopy, but it has a very limited field. A better system for astrographic work is the Schmidt camera, in which the aberrations of a spherical mirror are removed by a figured plate at its centre of curvature. Speaking as an optician with an interest in astronomy, Dr. Linfoot recommended a Schmidt telescope of aperture ratio about $f/3{\cdot}5$ and focal length 14 or 15 ft. (stop diameter 50 in. for an unvignetted field of 7°), convertible into a 72-in. spectrograph condenser by the addition of a small auxiliary convex mirror.

Dr. C. R. Burch, in agreeing with Dr. Linfoot's conclusions, appealed for a design which would not be determined by any cheese-paring austerity considerations. Quite apart from the astronomical value of a large telescope in Great Britain, its design and construction would, in his view, stimulate and inspire the technical opticians and the optical industry to an extent which would in large measure justify the cost. Astronomical optics has already provided new ideas for use in microscopy, for example, and there is no reason to believe that the fountain of good ideas has run dry.

To add point to this last remark, Mr. W. J. Bates then described a new device for testing mirrors which he has called a 'wave-front shearing interferometer'. Two views of the wave-front coming from the mirror are formed by division at a half-silvered surface, and are recombined with a relative displacement or shear. Interference fringes are thereby formed which are analogous to the contact fringes obtained by moving a test-plate of the same asphericity over the mirror under test. The method eliminates

the usual comparison beam necessitating a worked surface comparable in dimensions with that to be tested, and the apparatus (which was exhibited) in its present undeveloped state occupies about a six-inch cube. It might therefore be attached permanently to the telescope for frequent tests under working conditions.

Dr. W. M. Hampton, technical director of Messrs. Chance Bros. and Co., Ltd., next spoke on the construction of the mirror. As a material capable of taking a high polish, with a hard permanent surface and low thermal expansion, he said, glass is unrivalled. No technical difficulties would arise in the production of a 72-in. blank in Great Britain, though there would be serious commercial ones. A supply of suitable glass already exists ; the difficulty would be in the provision of facilities and especially space for transferring it from the furnace to the moulds and annealing kilns. Dr. Hampton emphasized, however, that his remarks applied to the glass for the main mirror, where its function is to provide an accurately figured surface. A Schmidt plate presents a very different problem, since the highest optical homogeneity is required for this, and a low-expansion glass has never yet been produced in the requisite optical quality.

The meeting then proceeded to more open informal discussion. A question from Prof. Greaves elicited the fact that, should an instrument of longer focal length than the 15 ft. of Dr. Linfoot's design be required to separate close images in densely populated Milky Way clouds, it could easily be obtained at the cost of a somewhat reduced angular field. In Prof. Plaskett's view, however, the overriding requirement is the resolution of the tremor disks of adjacent stars on the photographic plate, and the optimum focal length is set by this consideration. Mr. F. Hoyle welcomed the proposed telescope on the ground that if a large instrument could enable astronomy to contribute one really new idea to physics, the result might amply repay the initial cost. Mr. G. M. Sisson, of Messrs. Sir Howard Grubb, Parsons and Co., welcomed Mr. Hargreaves's design as a practical solution of the major difficulties, but deprecated the use of roller bearings, which deform seriously under load. He put in a plea for the modified English yoke mounting, especially if spectroscopic equipment is to add to the length of the tube, and hoped that the virtues of the Wright camera and of the Gaviola test would not be overlooked.

A lively discussion ensued on the practicability of various new materials for different components of the telescope. On a plea for high conductivity as well as low expansion for the mirror, even speculum metal was proposed, in view of the fact that vacuum evaporation has now removed the bogy of tarnishing. Technical difficulties of casting speculum metal, however, led another speaker to urge the superiority of a low-expansion cast iron such as 'Minvar'. Low thermal expansion, as Dr. Linfoot pointed out, is not necessary for the Schmidt plate, and the merits of 'Vitaglass' for the purpose were discussed. Transparent plastics, it was agreed, are quite unsuitable for this plate.

The discussion as a whole revealed extensive support for the views put so forcibly by the Astronomer Royal for Scotland in its early stages ; the desirability, even the necessity, of a large reflecting telescope in Great Britain was generally conceded. About the details of the design, divergences of opinion became apparent. But in a scheme of this sort, such differences are inevitable and are to be welcomed ; there will be time to thrash out the details when the principle is approved. It is clear that the main body of informed opinion among astronomers in Great Britain is in favour of the provision of a large telescope here, and there will be general support for the Royal Astronomical Society in its application for funds to construct and erect it. The prestige of the Royal Society has been lent to the scheme, and Sir Robert Robinson, president of the Royal Society, was able to announce at the opening of the Newton Tercentenary celebrations on July 15 that the Chancellor of the Exchequer would ask Parliament to devote a sum of money for the purpose. Details are not yet settled, but it is now agreed that the Isaac Newton Observatory, as it is to be called, should comprise not a mere 72-in. but a 100-in. reflector together with ancillary equipment.

POLYMERS AND POLYMERIZATION

On April 4, the Chemical Society held an afternoon symposium to discuss certain matters relating to high-polymer chemistry in which significant advances have been made recently. Six speakers contributed to the discussion, but, since the Chemical Society will publish the papers in full, only a few of the salient points of more general interest need be mentioned here. The first part of the discussion dealt with problems connected with the mechanism of the synthesis of high polymers, and the second part more particularly with the structure of such polymers.

The development of synthetical techniques has revealed at least three distinct ways in which macromolecules may be formed ; and the simplest from the purely chemical point of view is the process of polycondensation, exemplified by the combination of dihydric alcohols with dibasic acids to form superesters. These reactions take place by a step-like process. That is, each step is kinetically similar though not identical. The unfortunate fact is that polycondensations cannot be studied in dilute solution, and therefore it is impossible to determine whether molecular size has any effect at all on the magnitude of the kinetic coefficients ; nor is it possible to say why in any given case there seems to be a practical upper limit to molecular weight. The next important class is the polymerization of ethylene derivatives in the gas and liquid phases at room temperature and above. Here considerable progress has been made in getting a fairly detailed picture of the mechanism. The third class are those polymerizations which occur at low temperatures, for example, $-80°$ C. and are catalysed by substances of the Friedel-Crafts type, namely, BF_3, $AlBr_3$, etc. These are confined to hydrocarbons, though there is no doubt that other types of molecule may be made to polymerize in the same way. There may be other types of process, for certain peculiarities so far observed may not come under any of the above headings ; but these matters are still too uncertain to be profitably discussed here.

The Friedel-Crafts type of catalysis was discussed by Prof. M. Polanyi. The facts may be summarized briefly by saying that reaction occurs exceedingly rapidly, that products of higher molecular weight are obtained, that the reaction has a high negative temperature-coefficient. It would appear that besides

the catalyst a minute trace of water is necessary to start the reaction. Polymerization at higher temperatures certainly goes by means of free-radical mechanisms but, because energy of activation is necessary for the growth reaction, there is no likelihood of a similar mechanism operating at $-80°$ C. The low-temperature process must therefore occur by another mechanism not yet finally decided. Opinion strongly favours an ionic mechanism in which a proton first adds to an isobutene molecule

$$CMe_2{=}CH_2 + H^+ = \overset{+}{C}Me_2{-}CH_3,$$

a carbonium ion being thereby produced.

It is difficult to get any direct evidence of the existence of such an ion, because the concentration required to ensure fast polymerization is so extremely small. The so-called propagation or growth-step involves then the transfer of the positive charge to the monomeric unit just added:

$$CMe_2{=}CH_2 + \overset{+}{C}Me_2{-}CH_3 \rightarrow \overset{+}{C}Me_2{-}CH_2{-}CMe_2{-}CH_3.$$

This reaction must possess practically zero energy of activation since it occurs so readily. The growth can only be stopped by the neutralization of the positive charge or by the abstraction of a proton by a negative charge. The latter is the more likely process, and consequently the termination reaction is

$$\overset{+}{C}Me_2{-}CH_2{-}CMe_2{-}CH_3 + \varepsilon \rightarrow H^+ + CMe_2{=}CH.(CMe_2CH_2)_nCMe_2.CH_3.$$

The experimental difficulties in carrying out these reactions are so great that well-defined techniques cannot easily be applied to yield further information about the kinetics.

Prof. M. G. Evans discussed some further advances in studying the polymerization of a number of vinyl derivatives in aqueous solution; such as styrene, methyl methacrylate, vinylidene chloride. With the exception of methacrylic acid, the polymer is precipitated from solution; thus a new solid phase appears during the course of polymerization. It has been known for some time that hydrogen peroxide and also persalts catalyse polymerization, but the process can be considerably accelerated by the addition of a reducing agent, such as Fe^{++}. With the hydrogen peroxide–Fe^{++} system oxygen is evolved, but in presence of sufficient monomer it is supposed that the reaction

$$Fe^{++} + H_2O_2 = Fe^{+++} + OH^- + OH$$

occurs, and that the free hydroxyl radicals are taken up by the monomer. Normally, of course, two radicals would give rise to one molecule of oxygen although there is a competing reaction

$$OH + Fe^{++} = OH^- + Fe^{+++}$$

with excess Fe^{++}. In the latter case, $2Fe^{++} \equiv H_2O_2$, whereas in presence of monomer, $Fe^{++} \equiv H_2O_2$. Thus measurement of the rate of disappearance of the hydrogen peroxide gives at once the rate of production of hydroxyl radicals and therefore the rate of initiation of polymer chains. Although the absolute rate of interaction of hydroxyl with various monomers cannot be obtained, the relative values may be obtained using the $OH + Fe^{++}$ reaction as the basis of comparison. If hydroxyl radicals start polymerization by addition to a vinyl compound, thus forming $HO{-}(CH_2{-}CHX)_n.CH_2{-}CHX{-}$, there is the possibility they may add on to the chain and so ultimately stop growth. In such a case each polymer molecule would contain two hydroxyl groups. On the other hand, it may be that growth stops when two large free radical polymers interact. If these combine, a polymer molecule of the structure $HO{-}(CH_2{-}CHX)_nOH$ will also be produced. The number of polymer molecules in a given sample can be counted by means of an osmometer, and the number of hydroxyl groups by the methane evolved on treatment of the polymer with methyl magnesium chloride. The result is that there are two hydroxyl groups per polymer molecule. Kinetic analysis, however, shows conclusively that cessation of growth occurs by the combination of two radicals. This precise knowledge of the mechanism then enables the distribution of molecular weights to be computed on the assumption that the velocity coefficients for growth and termination do not depend on molecular weight. Fractionation of the polymer gives a result in good agreement with theoretical prediction. Emulsifying agents have a profound effect on the rate of reaction but do not affect the rate of production of hydroxyl radicals. Hence the growth or termination reactions must be affected, but no decision can as yet be made as to which process is affected. It is simplest to assume that the rate of termination is cut down.

Prof. H. W. Melville discussed a further extension of polymer kinetics, namely, the determination of the individual values of the velocity coefficients for the growth (k_p) and the cessation of growth (k_t). Measurements of the rate of polymerization can only give the ratio of k_p to k_t. In order to compute the individual values, another factor must be measured. This is the stationary concentration of the growing polymers. Owing to their high reactivity, the concentration (P) is invariably so small (for example, 10^{-9} moles/litre), that no physical method is sufficiently sensitive even to detect their existence. However, it can be shown that to a first approximation $d(P)/dt = (P)/\tau$, where $d(P)/dt$ is the rate of initiation of polymerization and τ is the time for growth of the chain.

$d(P)/dt$ can be obtained in both catalytically and photochemically initiated reactions, but τ can only be determined in photochemical reactions by making use of the fact that the rate is usually proportional to the square root of the intensity of the incident light, in which case with intermittent illumination the rate of polymerization depends on the frequency of the intermittency. By suitable analysis τ can be found. k_p and k_t can then be calculated as a function of molecular size and of temperature. With vinyl acetate in the liquid phase, it turns out that the energy of activation for the growth reaction is quite small—4,400 cal. The velocity coefficient does not diminish much with increasing molecular length. In pure monomer such a result is not surprising, because monomeric molecules must always be in the neighbourhood of the active end of the polymer at which growth occurs. The velocity coefficient for termination is not dependent on temperature, a fact which would not be surprising if termination of chains were due to the interaction of free radicals.

That the active polymer does in fact consist of free radicals is probable from these facts. It is practically certain that benzoyl peroxide gives rise on thermal decomposition to radicals that initiate free radical polymerization. Similarly, photochemical decomposition of the peroxide gives rise to a reaction with similar characteristics. Again, the direct photo reaction is similar to the photosensitized reaction. Exact molecular weight measurements of the resultant

polymer show conclusively that the large radicals disproportionate instead of combining.

The determination of the structure of high polymers is of the utmost importance, for the mere formulation of the chemical equation cannot indicate anything about the stereochemistry of the polymer, nor does it reveal side-reactions that may occur, giving rise to structures not expected from the 'straight' chemistry of the reaction. X-ray methods and infra-red methods supply some of the lacking information. Molecular weight determinations of high polymers must be made in solution, and hence it is of fundamental importance to have complete information regarding thermodynamic properties of their solutions.

What should be the most direct approach is the application of X-ray diffraction methods; but Mr. C. W. Bunn showed just how far such methods may be applied and also what severe limitations, and possibly insuperable limitations, still exist even with such a powerful method of attack. Before X-ray methods can be used, there must be produced within the solid polymer a considerable degree of internal order by the arrangement of the extended molecules in bundles. Unfortunately, this cannot be done with many polymers which have been thoroughly investigated by other methods. The most notable exceptions are polyacrylates and polymethacrylates, and polyvinyl acetate. The X-ray diffraction patterns produced by these amorphous polymers yield practically no information regarding their constitution. On the other hand, quite a number of vinyl polymers, poly-esters, polyamides, and polydienes give well-defined patterns indicative of a high degree of internal order, provided they are stretched as in rubber or are drawn into fibres as in polyamides.

The simplest example is polyethylene. Here there is a repeat distance along the chain of 2·5 A. This simply means that all the carbon atoms are coplanar in a large part of a single molecule. Similarly, if one of the hydrogen atoms of the ethylene unit is replaced by hydroxyl giving polyvinyl alcohol, the repeat distance remains unaltered. This means that all the OH groups are on one side of the backbone. Such an arrangement is highly uniform, and thus strong hydrogen bonding ensures easy crystallization of the polymer. The acetylation of the alcohol introduces a bulky group which prevents crystallization. If two bulky substituents replace the hydrogens on one carbon atom, the repeat distance is less than that of a fully stretched chain. The carbon chain must then be coiled to the same extent if normal internuclear distances are to be maintained. The same behaviour is exhibited by polyisobutylene because of the bulky methyl groups. There are, unfortunately, many ways in which chain-shortening can be carried out, and consequently the interpretation of the diffraction pattern becomes extremely difficult. In most cases a complete structure analysis must be made. Fortunately, with polymers such as polychlorobutadiene and guttapercha the analysis is possible; but with natural rubber the system has not yet been fully worked out. These complications increase with the size of the monomeric unit, but it is of interest to note that

$$-CO(CH_2)_4CO.NH(CH_2)_6.NH-$$

exists as a fully stretched molecule in the crystalline fibre.

The infra-red absorption spectrum of polymers provides a complementary method of structure analysis, as was pointed out by Dr. H. W. Thompson. In long molecules with repeating units, it is impossible to treat the whole molecule as a vibrating system as is done with small polyatomic molecules. Instead, the various types of links give rise to well-defined absorption bands. The precise position of such bands depends on the structure of the monomer units and also of their environment. One of the most important facts that has been established in certain polymers, for example, polyethylene, is the appearance of groups the presence of which would not have been inferred from the chemistry of the reaction. Small amounts of oxygen are used as a catalyst in this polymerization reaction, so that the proved presence of CO groups is not surprising, but the existence of CH_3 groups does raise serious questions regarding the mechanism of polymerization. In ethylene derivatives the disappearance of the double bond is so vital a change in the structure that small amounts of monomer may be detected in the polymer, and the progress of polymerization may easily be followed by watching the disappearance of the double bond. In the polymerization of dienes, infra-red methods enable a discrimination to be made between 1,2 and 1,4 structures, namely, $-CH_2-CH(CH=CH_2)-$ and $-CH_2-CH=CH-CH_2$ for butadiene. While it is true this could have been done by ozonolysis, the infra-red technique is speedier and more convenient.

Another recent discovery is that in substituted phenol formaldehyde resins the OH-frequency of the phenolic hydroxyl group is subject to wide variations, which would imply that orientation of the benzene rings in such resins may play a much more important part than has been realized in determining other properties. An unfortunate limitation is that in long polymers the nature of the end groups cannot be determined. This is one of the most pressing problems, because both chain initiation and termination are concerned at the ends of the molecule; yet little is known of the structures at the ends.

Dr. Geoffrey Gee discussed the thermodynamic approach to the investigation of the nature of solutions of high polymers. Unfortunately, the most difficult part of the subject concerns dilute solutions which are of interest for molecular weight determinations; but since concentrated solutions can be dealt with more satisfactorily, the analysis produces information about the function of plasticizers and about the interaction of polymers with solvents when swelling occurs. Briefly, the general argument is as follows. In considering the equilibrium between the solution of a polymer and the vapour in equilibrium with the solution, the fundamental quantity that governs the system is the Gibbs' free energy of dilution $-\Delta G$. From a knowledge of this quantity many important predictions may be made. Measurement of the effect of other factors such as temperature, surface tension and pressure permit additional factors to be computed, in particular the heat $-\Delta H_0$ and entropy ΔS_0 of dilution. The values of ΔG_0 and ΔH_0 so obtained thus provide data for inquiring more closely into the nature of the solutions, for this is much more complex than dealing with two miscible liquids. Assuming random mixing of polymer and solvent, it is presumed that ΔH_0 should vary as the square of the volume fraction of the polymer.

The important fact is that the constant of the equation expressing ΔH and volume fraction cannot be calculated from first principles, although an approximate estimate may be made from the cohesive

energy density of the liquid and an estimated value for that of the polymer, since this, of course, cannot be determined. According to statistical mechanics, the entropy of dilution is related to the logarithm of the number of ways in which a polymer chain can be arranged in the liquid. Here various restrictions must be imposed. The chain must be divided into units (not necessarily monomeric units) that are equal in volume to the solvent molecules. The chains must be completely flexible. The problem in statistics, then, is to calculate the maximum possible number of configurations. Unanimity of opinion has by no means been reached in this matter, but the general form of the equation is fairly well established.

Again, however, further work is necessary before a satisfactory solution can be achieved. It may be that statistical mechanics has reached a limit beyond which it cannot go because sufficiently complete information is not available about the nature of the polymer chain. Further progress will therefore be held up until new methods are devised to supply this lacking information.

COLLEGE OF AERONAUTICS

By E. F. RELF, C.B.E., F.R.S.
Principal

THE College of Aeronautics, which is to be opened at Cranfield, Bedfordshire on October 15, 1946, will treat advanced aeronautical education in a way which differs very considerably from that which has been followed in the past in British universities which have a department of aeronautics. In such universities post-graduate study in aeronautical subjects has been mainly of an academic character, and those students who have afterwards gone into industry have had to obtain their practical experience later, greatly helped by the sound general scientific or engineering background they had first acquired. The new College is intended to provide both the sound theoretical background and the practical training, and to show the relation between theory and practice as clearly as possible. It is hoped, in this way, to build up a centre of aeronautical learning of the highest standard, and to help to maintain British pre-eminence in the aeronautical world by training men who will ultimately become leaders of thought, whether in the industry, the research establishments, or in other places.

The history of this new endeavour begins in 1943, when Sir Stafford Cripps asked the Aeronautical Research Council to discuss the matter. On receiving a confidential report from the Committee, the Minister set up an interdepartmental committee presided over by Sir Roy Fedden to elaborate the scheme. The report of Sir Roy Fedden's Committee was published by H.M. Stationery Office under the title "A College of Aeronautics" (see *Nature*, 154, 621; 1944), and envisaged the building of a college near an existing airfield so that flying facilities might be readily available. A very full description of the aims and objects of the College was contained in this report, together with the reasons which led the Committee to advocate a new establishment rather than the extension of existing facilities in the universities and elsewhere. Appendixes to the report gave full details of the staff and equipment which would be necessary, and of the subjects to be covered.

It was evident that this extensive scheme could not be carried into full effect for a number of years, on account mainly of the difficulty of building in the immediate post-war years. The report itself suggested that an early start might be made by adapting existing buildings, and, after some exploration of possible sites, this plan was adopted and advantage taken of the offer of the Air Ministry to make a part of the R.A.F. Station at Cranfield available for the purpose. This Station has excellent brick buildings which have not been camouflaged, pleasant surroundings, and a very good airfield with unobstructed approaches.

The initial financing of the College was undertaken by the Government through the Ministry of Education, as recommended in the Fedden Report, which also recommended that control should be placed in the hands of a board of governors and that the control exercised by the Ministry itself should "not be too meticulous". The general atmosphere in the College was to be rather like that in a university, with considerable academic freedom for the staff. In June 1945 the Board of Governors was set up under the chairmanship of Air Chief Marshal Sir Edgar Ludlow-Hewitt, recently inspector-general of the R.A.F., and its members, appointed by the Minister of Education, represent a very wide range of interests connected with the College. The Board of Governors has laid down the broad policy to be followed and has appointed most of the senior staff of the College, who are now occupied with the task of preparation for the opening in October. The decision has been taken that Cranfield shall be the permanent home of the College, there being ample facilities for expansion as the need arises. The site is a convenient one, being almost equidistant from London, Oxford and Cambridge, and being quite near the new Research Establishment which is to be established at Thurleigh, north of Bedford.

At its inception, the College will consist of three main departments, dealing respectively with aerodynamics, aircraft design and aircraft propulsion, together with a flight section. As experience is gained, decisions will be taken as to the desirability of establishing other departments, such as those proposed in the Fedden Report dealing with aircraft instruments and with production. There will be sections under the three main departments covering ancillary subjects like mathematics, materials and metallurgy, electronics, and dynamics, so that students who need it can obtain sufficient instruction in these subjects to make their study of the primary subjects fully effective. The Flight Section will cater for the needs of all the departments and enable the students to follow their lecture-room and laboratory studies into the air and see how flight experimentation is employed to check and confirm theoretical and practical work in the design office.

The College will open with a two-year course at post-graduate level, though the actual possession of a degree is not essential for entry. In the first year, students will be given a broad general training in all the departments, while in the second year they will specialize in the subjects which they wish to make the basis of their subsequent career. It is intended later to establish short courses and refresher courses to meet any needs that become apparent. In all the courses particular care will be taken to ensure that fundamental principles are thoroughly grasped and understood, in order that students may be well prepared to deal with any problems they may

eventually meet. At the same time, the practical instruction in the laboratories will be made as extensive as possible, since so much of aeronautical knowledge at present rests upon the foundation of experiment.

The laboratories of the College will not be by any means complete at the date of opening, but will contain enough equipment to cover the first courses. They will be built up as time goes on and will ultimately become extensive. There will be two large laboratories containing wind tunnels of various kinds for the Department of Aerodynamics, including, in due course, small high-speed and supersonic tunnels. Two similar laboratories will be devoted to aircraft design and will contain testing machines and test frames in which the strength and elastic properties of complete wings and fuselages can be studied. The Engine Laboratory will contain examples of all kinds of engines, including some of the latest gas-turbine types, and there will be test houses in a more remote part of the College grounds where reciprocating and turbine units can be studied under running conditions. In addition, there will be many smaller laboratories to house smaller equipment and to cover the needs of the ancillary subjects. It is hoped that all these provisions will be completed in time for the commencement of the second-year course, in which the larger and more elaborate items of equipment will be more urgently needed than in the first year.

Every endeavour will be made to keep the teaching thoroughly up to date, a matter of the greatest importance in view of the fact that aeronautical science is progressing even more rapidly to-day than it has done in the past. For this purpose the closest touch will be maintained between the senior staff of the College on one hand and the industry and research establishments on the other. The fact that the Principal and some of the staff are closely associated with the activities of the Aeronautical Research Council will help greatly to ensure that the latest developments are known to those responsible for the teaching.

Students are now being selected for the opening course at the College. Selection is made by a board of entry and is based on a written application supplemented, when considered necessary, by an interview. Anyone who is interested can obtain all particulars by writing to the Registrar of the College.

The social amenities have not been forgotten; Cranfield is in a somewhat isolated position, being ten miles from the nearest town of any size, Bedford, and it is realized that much of the success of the venture will depend on the establishment of activities of a social nature within the College itself. There are good facilities for sports and games, and there will be excellent common rooms where staff and students can meet. It is also intended that the library shall contain cultural works as well as scientific and technical literature, since it is recognized that this side of the students' training is of very great importance and that the ability to use language easily and effectively is an enormous asset to the scientific man and the engineer which is often not sufficiently stressed.

The College is really an experiment in itself, for it is endeavouring to treat aeronautical teaching in a new way and has set itself a very high standard. Those who are in the best position to know are convinced that a period of great development in aviation lies immediately ahead, and that it will need no little effort to keep in the forefront of that development. The recent announcement concerning the establishment of a new research centre on a scale hitherto unheard of in Great Britain is a sufficient indication that Britain intends to make the attempt; but such measures would be useless without the *men* who can make them effective. It is here that the new College can be of great service by helping to ensure a flow of highly trained men of science, technicians and designers who will lead the aeronautical world of to-morrow in thought, in research and in practical realization.

THE RUHR COALFIELD AND ITS EXPLOITATION

It would be unfair to describe the report of a technical mission to the Ruhr Coalfield* merely as a valuable supplement to the well-known Reid Report on coal mining in Great Britain (see *Nature*, 155, 685; 1945), yet this is undoubtedly one purpose of this careful and detailed examination of the best mining practice in the Ruhr. One of the conclusions of the Reid Committee was that "the layout of the Continental mines with straight level roads driven through the strata provided a foundation for the reorganisation of the underground workings", and records of output per man-shift confirm that Ruhr mining methods should prove worthy of study. In 1938, under mining conditions comparable with those prevailing in Great Britain, the Ruhr coal miner produced 30·5 cwt. per man-shift; in the same year the British miner produced 23 cwt. per man-shift.

In the years following the First World War, there was a marked concentration of production in the Ruhr. The policy was that of replacing several coal winding shafts by one centrally situated, resulting in the creation of 'combined mines' with a daily output of 5,000–6,000 tons. By Ruhr standards this is a medium-sized mine, but in Great Britain a similar mine would be regarded as a major unit of production; indeed, there are very few mines in Britain capable of yielding an output of this magnitude. While some degree of concentration is inevitable in Britain, the Ruhr Mission does not recommend, on account of management difficulties, mines as large as the more modern of the Ruhr, which produce as much as 12,000 tons per day.

The inclination of the Ruhr coal seams has led to the development of the horizon system of mining. Briefly, the main development roads are driven in the solid strata, instead of in the coal seams as is the general practice in Britain. Under certain conditions the horizon system has many technical advantages, but most important is the fact that roads can be driven at gradients suited to locomotive haulage. The locomotive is widely used in the Ruhr, and the efficiency of haulage operations is emphasized in the present report. The trolley locomotive—most popular in the Ruhr—is at present barred from British coal mines by the stringent electrical regulations, designed to minimize the risk of explosions of firedamp or coal dust, and accidents due to electric shock. Nevertheless, the Mission recommends that

* Ministry of Fuel and Power and British Intelligence Objectives Sub-Committee. Technical Report on the Ruhr Coalfield. By a Mission from the Mechanisation Advisory Committee of the Ministry of Fuel and Power. (B.I.O.S. Final Report, No. 394.) Vol. 1. Pp. vi + 61. (London: H.M. Stationery Office, 1946.) 3s. net.

the trolley locomotive should be introduced into British coal mines, under suitable conditions, without delay.

British engineers have for some time been engaged in the development of machines to cut and load coal simultaneously. Machines of a similar type are being used in the Ruhr, but it is found that these are not so far advanced as those of British manufacture. The details of the 'Demag' machine may prove useful to those designing a machine for use in thin seams, and it is recommended that the drawings should be made available to designers in Great Britain. The coal plough, which removes a narrow strip of coal from a longwall face by power, has been the subject of much practical work in the Ruhr, and in the view of the Mission a standard German plough installation should be brought to Britain for trial and investigation; this appliance is a completely new departure in mining technique, and its application in the stronger coal seams of the country may be attended with considerable difficulty. Conveyors of all types have been inspected, and it is stated that Ruhr gate conveyor practice is not up to British standards. However, there are face conveyors of special design which should be brought for trial under British conditions.

Of especial interest to British mining engineers are the methods of mechanical packing practised in the Ruhr. It is universally recognized that the 'goaf' or space left after the extraction of the coal should be wholly or partially packed with debris. To the layman this is apparently a simple problem, and he often expresses a justifiable surprise at the mounting pile of debris to be seen at every pit head. However, the efficient packing of the goaves is a difficult and costly process, absorbing in most British mines a substantial number of workmen, engaged almost entirely in hand packing. Experiments have been made in Britain in mechanical packing, but the Germans have much wider experience of the organisation and equipment necessary for this purpose. For this reason the Mission recommends that the mechanical packing systems of the Ruhr should be applied, under suitable conditions, in British mines.

Ruhr winding practice has clearly reached a high standard of efficiency—a natural development following the centralization of winding arrangements. There are two features of German practice requiring especial attention, namely, the Koepe system of winding and the use of skip winders. It is sufficient here to say that the adoption of the Koepe system of winding would be a complete departure from normal British practice, since so far as the present writer is aware there is only one Koepe winder in Britain. Skip winding has proved to be both efficient and reliable in the Ruhr, and there are clear signs that the system is gaining favour in Britain.

The Mission pays high tribute to the excellent arrangements for the co-ordination of development and research. "A striking feature of the Ruhr coal mines is the similarity in equipment and mining practice. This similarity is due in no small measure to the activities of the development and research department of the Bergbau Verein (Coal Owners' Association)." This department was divided into two sections, one dealing with coal production, and the other with coal preparation and chemical matters. Committees were set up for the investigation of specific problems, and these were responsible for the direction of research workers and investigators, who were largely technicians drawn from the industry. Technical institutions and mining schools were also used for certain investigations. The duties of the department ranged over a considerable field, and every suggestion, from whatever quarter, had to receive the fullest inquiry. The German and foreign technical Press was carefully examined, and there is evidence that recent British patents have found application in German mining machinery. It is clear that the industry was well served by this comprehensive organisation, and it is suggested that a similar organisation would be of great value to the British industry.

Government publications on coal mining have been almost exclusively confined to safety and health. There is a paucity of literature relating to the best British and Continental mining practice, and in preparing publications of this type the Ministry of Fuel and Power is making a valuable contribution to the large-scale technical re-organisation which lies ahead of the British mining industry. Tribute must also be paid to the members of the Mission, for their industry in collecting so much information under difficult conditions and in the very short time at their disposal. It is to be regretted that it has not been found possible to publish Volumes 2 and 3 until a later date, particularly since Volume 2 contains the 195 diagrams referred to in the text. All interested in mining technology will look forward to the issue of the further volumes, and will hope that this is the forerunner of many other publications of this type.

H. HARTLEY

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

THE first General Assembly of the International Council of Scientific Unions since the War has just concluded its meetings, which were held at the rooms of the Royal Society, London, under the presidency of Dr. H. R. Kruyt of the University of Utrecht. More than seventy representatives of the principal scientific academies of a number of national research councils and of the various international scientific unions were present. The countries officially represented were Australia, Belgium, Canada, China, Czechoslovakia, Denmark, Egypt, France, Great Britain, India, Italy, Netherlands, Netherlands East Indies, New Zealand, Norway, Peru, South Africa, Sweden, Switzerland, United States and Yugoslavia. In addition, as guests a welcome was extended to M. A. Establier and Mme. Malterre of the International Organisation of Intellectual Co-operation of the League of Nations, and to Dr. J. Needham, head of the Scientific Division of the Preparatory Commission of the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

The president in his address mentioned the heavy losses that the Council had suffered by death since its last meeting in 1937. The Executive Committee alone had lost its president, Prof. C. Fabry; two vice-presidents, Il Marchese Marconi, and Baron Joji Sakurai; Prof. H. Abraham (murdered by the Gestapo), General Bourgeois, Sir Arthur Eddington, Prof. Parravano, General Perrier, Dr. Philippson, and Sir Albert Seward, officers of the separate unions which they represented on the Executive Committee.

The president explained the functions of the Council as the international organisation co-ordinating the

national academies and the scientific unions. Its immediate task was to stimulate the formation of unions in branches of science where no union at present existed and to organise scientific activities in those borderland domains which are intermediate between those of two or more unions. The existing committee of the Council on Solar and Terrestrial Relationships provided a good example of what results could be obtained from these intermediate fields of knowledge. It was proposed to make the Committee a joint commission of the Unions of Astronomy, of Geodesy and Geophysics and of Radio Science. New joint commissions and new unions were in view.

There had been discussions with the Scientific Division of the United Nations Educational, Scientific and Cultural Organisation on the possibility of co-operation within their respective fields, and a draft agreement would be submitted to the meeting and referred to the Organisation for ratification later in the year. This new agreement would replace the one officially made in 1937 with the International Organisation of Intellectual Cooperation of the League of Nations with whom for a short time the International Council had had very happy relations. The War had cut right across their schemes for mutual assistance and the agreement had been terminated by notice from the Organisation, which would cease to exist when the United Nations Educational, Scientific and Cultural Organisation came into being.

The Assembly would also be discussing problems arising from the impact of scientific research on the life of the community and also the ethical responsibility of the individual man of science. He hoped that the result of their discussions would be to give this meeting an honourable place in the history of the International Council.

The opening session, after the welcome by Sir Robert Robinson, president of the Royal Society, and Prof. Kruyt's address, was devoted to a general discussion of the future development of the Council's activities and of the policy to be pursued. The general effectiveness of small unions and of large unions with specialized sections or associations was fully discussed; Prof. Kruyt summed up the discussion by saying that the various unions existed to co-ordinate the activities of the scientific workers and that the problem of separation or union could be left to work itself out later.

The second session was devoted to the draft agreement with the United Nations Educational Scientific and Cultural Organisation. As this has not yet been ratified by the Organisation, full details cannot be given; it may be stated, however, that it involves recognition of the several unions and the International Council by the Organisation (and of the Organisation by the Council); close consultative relations between the Council and the Organisation, with at least one liaison officer of the International Council at the headquarters of the Organisation; offers of help from the Organisation to ease the administrative burden that now falls on the secretaries of the Council and unions; assistance, both financial and other, in getting scientific persons to conferences and symposia; and financial assistance in some of the major projects of the unions.

At the third session, reports were read from all the unions, indicating that they had already begun to re-start their pre-war activities, so far as these had necessarily been dropped during recent years, or that they were to hold their initial post-war meetings as soon as proved practicable. On the whole, the reports sounded a more cheerful and hopeful note than had seemed likely in advance; despite the recent difficulties that the unions had been facing, international co-operative work had continued wherever possible and much fresh work was in prospect.

A resolution proposed by Prof. J. Hadamard on the difficulties arising from the restrictions imposed by the exchange control on the free interchange of scientific publications was referred to the Executive Committee for discussion with the United Nations Educational, Scientific and Cultural Organisation.

Amendments of the statutes followed. The more important changes were: (1) the speeding up of the working of the Council by giving to the Executive Committee powers previously kept in the hands of the General Assembly; (2) an increase in the unit of subscription from the adhering countries. This was needed to meet the increased activities called for on the part of the Executive Committee—more frequent meetings and reports.

The fourth session was devoted to the reports of two committees of the Council. Prof. Abetti presented the report of the Committee on Solar and Terrestrial Relationships: the *Quarterly Bulletin of Solar Character Numbers* had now been published up to 1944. Of the present separate character number of the sun only the sunspot number would be given in future bulletins: details of solar eruptions would continue to be published and fresh solar data, especially coronal phenomena now made available by the pioneer work of Lyot.

Prof. J. M. Burgers presented and summarized the report of the Committee on Science and Social Relations. He explained that owing to the difficulties of communication and the short time available to gather in the material asked for by the Executive Committee, there had been no time for discussion by the Committee on Science and Social Relations itself.

A vigorous discussion followed on resolutions submitted by the Committee and an additional resolution proposed by Prof. A. V. Hill. Reference was made in the discussion to the remarks of the president of the Royal Society in his address to the Council at its opening meeting: his final passage may be quoted:

"The prevailing spirit among scientists at the present time should surely be one of hope and optimism. Opportunity knocks at the door. We may well be at a critical point in history the turning of which cannot be accomplished without our assistance. This Council is in a unique position to focus our efforts to maximum intensity and that is why I have ventured to emphasize the necessity for circumspection and the dangers of an attitude of aloofness from the body politic. Wisely used, the most pervasive faith in the world, the religion of the pursuit of truth for its own sake, may be the most potent instrument of reconciliation and reconstruction. Thus we may help to lead the nations into amity and the prosperity which flows from long-continued peace."

In the light of the discussion, the Committee on Science and Social Relations was asked to revise its draft report and, in consultation with the Bureau of the Council, to amend slightly the wording of the resolutions.

At the final meeting, the resolutions as given below were brought forward. Prof. Niels Bohr gave his support, Prof. A. V. Hill quoted Sir Henry Dale as being cordially in favour, and Col. Dianderas approved the resolutions in the name of the government, the universities and the men of science of Peru

and more generally as a representative of South America. The resolutions were adopted unanimously; they are printed below:

1. The General Assembly of the International Council of Scientific Unions sees in the great powers for good or evil that research on nuclear energy has put at the disposal of mankind a supreme opportunity and occasion for a new international unity, to develop the benefits potential in nuclear energy and to avoid its misuse. The General Assembly strongly supports the efforts now being made under the auspices of the United Nations to attain this urgent goal, efforts in which the co-operation of representative men of science, so essential for success, are being officially given. The General Assembly urges that the present opportunity of eliminating war by the attainment of such a new international unity be grasped.

The General Assembly hopes that the attainment of an agreement on the application of nuclear energy may provide an important instance of international co-operation in economic and political matters. Extension of this would facilitate the promotion of the welfare of mankind, the judicious use of our natural resources, the removal of causes of dispute and the settling of difficulties arising from the continuous change of world conditions in consequence of scientific and technical advances.

2. The General Assembly is aware that nuclear energy is not unique among scientific advances in its possible effects for good or ill. Biological and biochemical warfare, for example, were not applied during the late conflict, but their potential menace may be as great as that of the atomic bomb: equally, the discoveries on which they depend could bring the greatest benefits to mankind.

The General Assembly is convinced that international security and welfare will be impossible if, in any country for the future, military secrecy is allowed to dominate scientific discovery or to prevent the frank discussion and open publication of scientific results. There can be no international control and no international co-operation which does not presuppose an international community of knowledge.

3. The General Assembly of the International Council of Scientific Unions, in the name of the men of science of the nations represented, acknowledges the duty on the part of scientific workers:

(*a*) to maintain a spirit of frankness, honesty, integrity and co-operation and to work for international understanding;

(*b*) to promote the development of science in the way most beneficial to mankind and to exert their influence as far as possible to prevent its misuse;

(*c*) to serve the community not only by their specialized work but by assisting so far as they are able in the education of the public in the purposes and achievements of science.

An invitation from the Royal Danish Academy to hold the next meeting of the General Assembly in Copenhagen in 1949 was accepted with acclamation.

The following were elected as the members of the Bureau: *President:* Dr. J. A. Fleming, adviser to the Carnegie Institution in governmental and international scientific relations; *Vice-Presidents:* Prof. B. Němec (Prague), Prof. Emile Borel (Paris); *Members:* Dr. J. N. Mukherjee (New Delhi), Prof. H. Solberg (Oslo); *General Secretary:* Prof. F. J. M. Stratton (Cambridge); *Retiring President:* Dr. H. R. Kruyt (Utrecht).

OBITUARIES

Dr. H. A. Colwell

Dr. H. A. Colwell, who died on July 22 at the age of seventy, was a medical writer of outstanding distinction, especially in the field of radiology. He qualified at St. Bartholomew's Hospital in 1900; later he became M.R.C.P. and submitted a thesis which gained him a Ph.D. at the University of London.

Colwell served as a pathologist in the cancer research laboratories of the Middlesex Hospital for some years; the years 1914–18 saw him serving with the R.A.M.C. in Salonika. He was a fine linguist, and this, combined with a wide range of qualifications in medicine, made him an invaluable officer; at the end of two years service he contracted dysentery and was invalided to Malta. On returning to England he took up work in radiology with Robert Knox, and eventually took charge of the Department of Radiotherapy at King's College Hospital, London.

As an experimentalist he collaborated with Russ on the conversion of starch into dextrin by X-rays, and with Gladstone on the effects of repeated small doses of X-rays upon the chick embryo, a subject with an obvious bearing on X-ray therapy.

Dr. Colwell was a fine writer with the scrupulousness of a scholar, and it is as a writer that he will long be remembered; his chief works were with Russ as co-author. In 1915 they wrote "Radium, X-rays and the Living Cell" at a time when the biological effects of radiations were more and more the subject of experiment, and the book was welcomed by those who were taking the subject of radiology seriously. Nearly twenty years later, the evidence of injuries caused by the radiations was collected in book form and appeared as "X-rays and Radium Injuries". Colwell would talk and write forcibly on the subject of quackery, and he was incensed at its association with radium; at that time people were being induced to drink water charged with radium, to eat chocolate containing radium and to believe that radioactive toilet preparations such as hair restorers, skin lotions and face masks brought special benefits to their users. Colwell's comment was: "One thing about such preparations is quite plain, if they are not radioactive as they claim, they are fraudulent, and if they fulfil that claim, they are dangerous". He published an introduction to the study of X-rays and radium with Wakeley and a delightful book on the history of electrotherapy. His wide knowledge and experience of the subject brought him the Garton Gold Medal and Prize of the British Empire Cancer Campaign for an essay on the "biological effects and mode of action of radiations upon malignant and other cells".

Hector Colwell was at heart a scholar, and no sort of intellectual activity came amiss to him; he was a delightful pianist and a man to whom languages came easily, a quiet retiring man of great charm to those who came within the circle of his friendship. His wife (née Clara Wood) predeceased him in January, and he never recovered from her loss.

Prof. Ernst Freund

With the death on June 2 of Prof. Ernst Freund a great biochemist has passed away. He was a singular scientific personality, whose work did not rest on the results of contemporary research, but always originated from a sudden discovery of new,

paths of thought. He had been suffering from ill-health for about a year, but he carried on his research work until his death took place in London.

Freund was born in Vienna in 1863. He graduated as an M.D. at the University of Vienna in 1886. His first publication, "Zur Diagnose des Carcinoms", was published in 1885, when he was still a student. Dissatisfied with the predominantly toxicological and hygienic trend of the type of medical chemistry taught at that time, Freund proceeded in 1890 to found his own biochemical laboratory, which became attached to a large Viennese hospital. Its purpose was to put chemical research at the disposal of the clinics. It was the first biochemical laboratory in Austria, and one of the first of its kind in the world. The importance of this laboratory for the development of biological and clinical chemistry in the old medical centre of Vienna was very great indeed. The results of the activities of his laboratory will be found in many volumes of *Hofmeister's Beitraege*, as well as in the first 255 volumes of the *Biochemische Zeitschrift*.

During this time, Freund's interests were focused on a variety of problems: the isolation of different serum globulins; the role of the intestine in protein metabolism; the presence of albumoses in blood and urine; the composition of urine in infections, especially pneumonia, and in other pathological conditions; the presence of specific nucleo-proteinases in urine; the development of simple methods for the isolation and determination of nitrogen-containing substances in urine, among them of the colloidal fraction of the so-called oxyproteinic acids. The inhibition of blood clotting by keeping the blood in paraffinized vessels was first observed by Freund. He isolated cellulose from miliary tubercles and based a treatment of tuberculosis on the exclusion of cellulose from the diet.

The year 1912 brought a decisive reorientation of Freund's work, which from now on became predominantly connected with cancer research. Jointly with his devoted co-worker, Dr. Gisa Kaminer, he discovered that normal blood serum has the power of dissolving carcinoma cells, whereas blood serum of carcinoma patients does not. Thus the first serological cancer reaction was found. Freund himself linked up his great discovery with yet another concept, that of cancer disposition, and he deduced the possibility of diagnosing cancer in its earliest stages, as well as predisposition to this disease. It is sometimes not realized that Freund's cytolytic reaction is an independent experimental fact which has been confirmed beyond doubt. Freund and his collaborators then proceeded to connect the serological changes with changes in the intestinal bacteriological flora. He tried to control this flora by intestinal disinfection and, above all, by a certain diet, the essential features of which were high protein and low carbohydrate content, complete absence of animal fats, and their replacement by vegetable fats. This diet was tried on animals with experimental cancer as well as on human cases; many inoperable cases showed appreciable, sometimes very great, improvement. Again Freund had broken new ground by demonstrating results the importance of which remains independent of the background of his theory.

At this stage Freund, who had retired from the University, found the interest and powerful support of Mr. Frederick F. A. Pearson, who founded a cancer hospital for dietary treatment of cancer cases, mainly in inoperable stages. During this period Freund also developed new ideas regarding the pathogenesis of rheumatism, which again he linked up with changes in the intestinal flora. With the annexation of Austria, Mr. Pearson transferred his foundation to London, where Freund continued his research work with indefatigable zeal.

Freund's enthusiasm and scientific inspiration was matched by a deep devotion to his humanitarian mission. His modesty and profound kindness added to the fascinating charm of his personality, and it was significant that his co-workers wanted to become also his friends, and his friends to become also his co-workers.

R. WILLHEIM

Prof. J. Uzel

PROF. J. UZEL, professor of agricultural and forest zoology at the Czech Technical College in Prague, died on May 19 at the age of seventy-eight. From childhood he was interested in natural science, and he studied in the faculty of science and philosophy at the Charles University of Prague and at the University of Berlin.

Uzel's chief interest was zoology, especially entomology. His first study was of the group Apterygota. In 1890 he wrote "Šupinušky země České" (Thysanura of Bohemia). For this work he gained an award from the Charles University. Another work on the same group was "Studien über die Entwicklung der Apterygoten Insecten (Berlin, 1898). Meanwhile, as the result of research and careful microscopical observations over a period of years, he produced "Monografie řádu Thysanopter" (a monograph of the order Thysanoptera, 1895). This book, of some five hundred pages, is a fundamental work in this branch of entomology. In it Uzel described many new species of these small, but often serious, agricultural pests. For this book he received an award of the Czech Academy of Sciences.

In 1896 Uzel obtained his doctorate, and then he devoted himself to science and travelling, becoming well known in the scientific world. In 1901 he was invited to Ceylon by Willis, then director of the Royal Botanic Garden in Peradeniya. There he worked as an entomologist for a year. In 1903 the German Government offered him the post of entomologist at the biological station in Amani in Africa. He refused and accepted a position as chief of the research station for the sugar industry in Prague. There he built up a phytopathological department. He took an active part in the protection of sugar beet and published many practical and scientific papers, most of them published in the *Zeitschrift für die Zuckerindustrie in Böhmen*. During the years 1909–10 he was again studying the fauna in the East Indies and Ceylon.

In 1905 Uzel became a lecturer at the Czech Technical College in Prague, in 1909 he was appointed an extraordinary professor of phytopathology, and in 1920 ordinary professor of agricultural zoology and entomology. Not far from Prague he had a biological station, associated with his institute of zoology. For his scientific work Uzel was in 1905 elected to the fellowship of the Czech Royal Society.

In recent years Uzel took up the study of philosophy. He published many papers, and in 1926 a book in Czech, called "Nature is a Gospel" (German edition: Die Natur ein Evangelium, 1937). In this book he gives a summary of his own philosophical

views, which had considerable influence on Czech free religious movements.

During his life Uzel collected at home and abroad much entomological material. This is deposited in the Prague Museum, the Agricultural Museum in Prague, the Natural History Museum in Vienna and in the Museum at Peradeniya. His collections in the Zoological Institute at Prague were destroyed by the Germans during the occupation of the country.

Altogether Uzel published some four hundred papers; a chronological survey of them has been published in Czech: "Work and Life of Prof. Dr. J. Uzel" (Prague, 1938). K. Čermák

We regret to announce the following deaths:

Mr. G. H. J. Adlam, O.B.E., editor since 1919 of the *School Science Review*, on July 30, aged seventy.

Mr. Asa Binns, formerly chief engineer to the Port of London Authority, and a past president of the Institution of Mechanical Engineers, on July 2, aged seventy-two.

Sir Francis Carnegie, C.B.E., during 1926–44 chief superintendent of ordnance factories, Royal Arsenal, Woolwich, on August 3, aged seventy-two.

Prof. J. Laird, regius professor of moral philosophy in the University of Aberdeen, on August 5, aged fifty-nine.

NEWS and VIEWS

Mathematical Physics at Cambridge: Prof. D. R. Hartree, F.R.S.

Prof. D. R. Hartree, who has been appointed Plummer professor of mathematical physics in the University of Cambridge, in succession to the late Sir Ralph Fowler, was born in 1897 and educated at Bedales. During the First World War he was a lieutenant in the R.N.V.R., and worked at the Anti-Aircraft Experimental Section at Whale Island as a member of a famous team of scientific men under the direction of Prof. A. V. Hill. Going to Cambridge, he took the Natural Sciences Tripos in 1922 and was elected a fellow of St. John's College in 1924. After one year (1928–29) as University demonstrator in physics, Hartree was elected Beyer professor of applied mathematics in the University of Manchester, which post he held until 1937, when he became professor of theoretical physics in the Physical Laboratory at Manchester.

Prof. Hartree's earlier work was mainly connected with the calculation of the energy-levels and wave-functions of atomic structures. He possesses a great gift and liking for numerical mathematics, and this aptitude he displayed to the full in this field, which he has made peculiarly his own. Later on, when he felt that he had sufficiently exploited 'pencil and paper' methods, he decided that a differential analyser was needed to develop the work further. Taking as a model that of Prof. Bush at the Massachusetts Institute of Technology, a differential analyser was built by Metropolitan-Vickers for Prof. Hartree and housed in the Physical Laboratories, Manchester. This instrument, the first made in Great Britain, has been used for very many other purposes than calculating atomic properties. For example, it has been fully employed during 1939–45 on technical problems for the Services and for industry. During the Second World War, Hartree was employed by the Ministry of Supply on very many problems of importance, particularly in the field of internal ballistics of rockets, of the propagation of radio waves, and of the theory of the magnetron. He was chairman of the Ministry of Supply Panel on servo mechanisms, which has played a very valuable part in co-ordinating work on servo-mechanism throughout Great Britain. In 1939 he gave the Kelvin Lecture to the Institution of Electrical Engineers. Recently Hartree's interests in calculating machines have led him to study American work on electronic calculators. He has just returned from a visit to the United States, where he worked at the University of Pennsylvania with the E.N.I.A.C. (see *Nature*, April 20, p. 527). Hartree's appointment to the Cavendish Laboratory will bring him into touch with many fields of physics where his mathematical and computational ability will find full scope.

Bacteriology at the University of Sheffield: Prof. C. P. Beattie

Prof. C. P. Beattie has been appointed professor of bacteriology in the University of Sheffield in succession to Prof. Wilson Smith, who recently left the University to occupy the chair of bacteriology at University College Hospital Medical School, London. Prof. Beattie was educated at Fettes College and the University of Edinburgh. After clinical and bacteriological experience in the hospitals and University of Edinburgh, he spent a period of study and research in the United States and in France with a Rockefeller fellowship, returning to Edinburgh to be lecturer in bacteriology in 1933. In 1937 he was appointed professor of bacteriology in the Royal Faculty of Medicine of Iraq and director of the Government Bacteriology Laboratory, Baghdad, which he started and organised as the bacteriological centre for the whole of Iraq, charged with the preparation of protective vaccines and sera as well as the conduct of bacteriological examinations. Prof. Beattie's own researches have covered a wide field of diseases, some common in Great Britain, some peculiar to Iraq; among his many other duties was the setting up of a quarantine laboratory for the examination of pilgrims returning from Mecca. Prof. Beattie will take up his duties at Sheffield at the beginning of October.

Anti-Locust Research Centre

During the War, the Anti-Locust Research Centre concentrated on forecasting and advisory services for anti-locust campaigns in Africa and the Middle East; but now a grant for developing research activities has been made under the Colonial Research and Development Act, and Dr. D. L. Gunn, formerly of the University of Birmingham, has been appointed principal scientific officer to take charge of this side of the work. It is hoped that the co-operation of university departments, mainly in zoology, can be enlisted, as funds are available to provide some grants to research students willing to undertake laboratory work on selected problems, or to take part in field investigations abroad, particularly in connexion with

aircraft methods of locust control. Both fundamental problems of locust physiology, behaviour, etc., and the problems of control are in the programme. Workers interested in such problems and heads of university departments who may be able to offer laboratory facilities are invited to write to the Director of the Centre, British Museum (Natural History), London, S.W.7.

Accommodation for Scientific Workers in Danish Laboratories

THE Preparatory Commission of the United Nations Educational, Scientific and Cultural Organisation, 47 Belgrave Square, London, S.W.1, has received from Denmark an offer to accommodate free of charge up to two hundred graduate scientific workers from war-devastated countries in Danish laboratories and technical colleges. The invitation, which is not open to students, applies particularly to graduate scientific workers who, due to the effects of war, are unable to obtain the requisite laboratory facilities in their own countries, whether in Europe, the United Kingdom, China, the Philippines or Iran. All tuition and laboratory fees will be waived for a period up to two years. Travel and living expenses are expected to be met by the visitors' government. In exceptional cases the Danish authorities will consider defraying these expenses also. On a reasonable scale a single person can live for about Kr. 5,000 (about £250) a year in Denmark. The scheme is being sponsored by the Danish Committee for the Training of Foreign Scientists in Danish Laboratories.

Recent Earthquakes

AN earthquake with probable epicentre in the Strait of Georgia 20 miles west of the City of Vancouver and of some severity shook central districts of Vancouver Island on June 23. Buildings, especially in the north and west of Vancouver Island, swayed considerably and some chimneys collapsed. The depth of water in lakes in the interior of Vancouver Island and also the depths of water along the eastern coast of the Island changed considerably. Several beaches became submerged to a depth of 100 ft., and the Canadian Hydrographic Department has ordered the taking of new soundings in the strait for navigational purposes. Dr. E. A. Hodgson has pointed out that there was no immediate aftershock to this earthquake. The earthquake was registered on the seismographs in Switzerland, preliminary pulses arriving at Zurich at 17h. 25m. 05·2s. G.M.T. They were also recorded at Toledo in Spain at 17h. 25m. 13s. G.M.T.

On July 1 an earthquake originated near Fairbanks, Alaska (U.S. Coast and Geodetic Survey), and on July 18 an earthquake at 6h. 07·1m. G.M.T. with aftershock at 7h. 16·5m. G.M.T. had their epicentres at lat. 50° N., long. 129° W., which is in the Pacific Ocean just off Cape Cook (north-west Vancouver Island) and north-west of the earthquake of June 23. The epicentre of the July 18 shock was determined by the U.S. Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association from instrumental readings from fifteen observatories. The depth of focus was estimated to have been rather less than 100 km., which is deeper than normal.

The slight earth tremor which was felt at Leyland in Lancashire about 7 a.m. B.S.T. on July 21 is now believed to have been caused by an explosion in a 100 ft. borehole. Prospecting for oil by seismic means was proceeding. The effect at Leyland was greater than expected for a normal shot.

On August 4 an earthquake of considerable severity originated in the Atlantic Deep, north-west of Puerto Rico. Severe shocks were felt at Puerto Rico, Trinidad, and Ciudad Trujillo on Haiti, and high waves swept into the ports of Matanzas, Puerto Plata, and Ciudad Trujillo. The docks and some ancient churches in this latter city were slightly damaged, and the telephone service was temporarily interrupted at Puerto Rico; but considering the energy of the shock as registered on seismograms throughout the world, surprisingly little damage was done in towns near the epicentre. Strong aftershocks of the earthquake continued at intervals for a week.

Flight Research Section of the Canadian National Research Council

A FLIGHT RESEARCH SECTION of the Division of Mechanical Engineering of the National Research Council is being set up at the Royal Canadian Air Force Station at Arnprior, Ontario. This Section will be financed and operated by the National Research Council. The aerodrome will remain the property of the Department of National Defence for Air, but is leased to the Research Council. The R.C.A.F. will supply flying personnel, aircraft and maintenance staff. Research activities will be under the direction of the National Research Council. It will be a small establishment with probably not more than a hundred men and five aircraft. It is to contain a nucleus of trained flight research personnel and equipment, the object being to do basic research without the interference of normal air traffic. In the laboratories of the Division of Mechanical Engineering of the National Research Council near Ottawa three wind tunnels—two horizontal and one vertical—provide excellent facilities for studies on models of aircraft to determine the probable performance of full-scale aircraft in flight. The Flight Research Section will provide the means of securing necessary additional information to supplement and amplify the results obtained on model tests in the wind tunnel.

Scientific Work in Germany

DR. H. KALMUS, of the Galton Laboratory, University College, London, W.C.1, has received the following information from the French zone of occupation of Germany, in a letter from Prof. Alfred Kühn. Prof. Alfred Kühn left the Zoological Institute in Göttingen in 1937 and went to the Kaiser-Wilhelm Institut für Biologie in Berlin. In the autumn of 1943 he was able to evacuate his department from there to Hechingen, Hohenzollern, and thus all his apparatus and library have been saved. Work in this institution has continued since the occupation first by the Americans and then by the French under the protection of the American T-force and the Mission Scientifique. In December 1945, Prof. Kühn was appointed to the chair of zoology in the University of Tübingen in the French zone of occupation, and he is now trying to move the other biological departments of the Kaiser-Wilhelm Institute to Tübingen. A botanical department under Melchers, working on plant hormones and plant viruses, has provisional quarters in the botanical department of the University. Hartmann and Bauer are working in Hechingen, Hohenzollern, and Hämmerling in Langenargen am Bodensee in

the Institute for Limnology. Prof. Kühn has lost all his close collaborators and is training young workers. His main interest at present is the chemical action of genes; in this work he is collaborating with Prof. Butenandt, who occupies the chair of physiological chemistry in Tübingen.

Study of Photo-elasticity

It has been suggested that a society or association should be formed in Great Britain for men of science and engineers who are interested in the development and applications of photo-elasticity. Such an organisation would enable research workers in this field to keep in touch with each other and, in particular, would provide a common meeting ground for workers in industrial, government and university laboratories. Messrs. H. T. Jessop (Engineering Department, University College, Gower Street, London, W.C.1) and E. K. Frankl (Cambridge University Engineering Department, Trumpington Street, Cambridge) state that it is proposed to arrange a meeting on September 6 at 11 a.m. at University College, London, at which the general character and aims of such a society could be discussed. Communications about the meeting should be sent to Mr. Frankl at the address given above.

Association of Special Libraries and Information Bureaux: Annual Conference

The twenty-first conference of the Association of Special Libraries and Information Bureaux will be held at the Polytechnic, Regent Street, London, W.1, during September 13–15, and a provisional programme has been issued. The presidential address, by Sir Reginald Stradling, will be given on September 14, and the subject is "Special Libraries in Research Organisations". Papers have been promised on the preparation of critical bibliographies (A. D. Roberts, British Library of Political and Economic Science), communication of specialist information to business executives (Prof. R. S. Hutton), mathematical machines and tables (Dr. L. J. Comrie, Scientific Computing Service, Ltd.), and technical dictionaries and glossaries (Miss M. Gosset, Science Library). A symposium on aspects of documentation in Europe has been arranged for September 15 (morning session), at which Mrs. Lancaster-Jones (British Council) will deal with the European demand for British scientific literature, Miss Esther Simpson will speak on the Society for Visiting Scientists, and Ronald Fraser (Control Commission for Germany and Austria) on Germany; information services in other European countries will also be surveyed. Further particulars of the conference can be obtained from the Association of Special Libraries and Information Bureaux, 52 Bloomsbury Street, London, W.C.1.

University of London Appointments

The following appointments in the University of London have been announced: Dr. S. E. Hollingworth, a senior geologist in H.M. Geological Survey, to the Yates–Goldsmid chair of geology tenable at University College, as from October 1; and Dr. Ronald Hare, of the Connaught Laboratories, University of Toronto, to the University chair of bacteriology tenable at St. Thomas's Hospital Medical School, as from October 1.

The following titles, in respect of the posts indicated, have been conferred: Mr. W. R. Spurrell, Guy's Hospital Medical School, to be professor of physiology in the university; Dr. L. E. Bayliss, University College, to be reader in physiology in the University; Dr. S. J. De Navasquez, Guy's Hospital Medical School, to be reader in pathology in the University; Dr. R. W. B. Pearce, Imperial College of Science and Technology, to be reader in spectroscopy in the University; Dr. R. J. V. Pulvertaft, Westminster Hospital Medical School, to be professor of clinical pathology in the University; Dr. W. D. Wright, Imperial College of Science and Technology, to be reader in colour vision in the University; Dr. C. E. Wynn-Williams, Imperial College of Science and Technology, to be reader in physics in the University.

Karel Preis (1846–1916)

Although not widely known outside Central Europe, Karel Preis contributed to the advance of two sciences, founded a sugar research station and a now famous technical museum. His parents were French, probably settling in Bohemia as young refugees during the Napoleonic wars. At one time his father had a wine business in Prague, where Karel was born on August 20, 1846. After studying chemistry and other sciences at the Polytechnic, Preis was eventually made a professor there in 1868. In his small analytical laboratory he engaged upon a series of minor researches, and one of his earliest discoveries related to a double sulphide of iron and potassium, K_2S,FeS, which he made by heating sulphur, reduced iron and potassium carbonate together to bright redness. Ten years later (1879), together with B. Rayman, he studied the action of nitric acid on cholesterol and cholesteryl chloride, and in 1884 they prepared and examined the bromides of tin. They isolated a number of derivatives and studied the reactions of the tin halides with water, ammonia and other substances. In addition to these researches, Preis wrote a number of textbooks and trained many successful technical chemists, particularly for the sugar industry. He was editor of the *Chemické Listy* for twenty years and of the sugar journal, *Listy Cukrovarnické*, for thirty-three years. Moreover, Preis was a keen naturalist and collector of insects; he wrote a monograph on Czech Hymenoptera.

Announcements

Prof. Arthur Holmes, regius professor of geology in the University of Edinburgh, has been elected a corresponding member of the Geological Society of Belgium, in recognition of his important contributions to geological science.

Prof. H. S. Raper, since 1923 Brackenbury professor of physiology and director of the Physiological Laboratories in the University of Manchester, has been appointed dean of the Medical School and professor of chemical physiology in the University. Dr. W. Schlapp, reader in experimental physiology and assistant director of the Physiological Laboratories, has been appointed to the Brackenbury chair and to the directorship of the Physiological Laboratories.

Erratum. The ordinates of the graph accompanying the communication entitled "Effect of *p*H in the Dye Titration of Vitamin C in Certain Plant Materials" by Dr. F. Wokes in *Nature* of July 27, p. 133, should read "100, 75, 50, 25" and not "10, 7, 5, 2" as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fluctuations in Cosmic Radiation at Radio-Frequencies

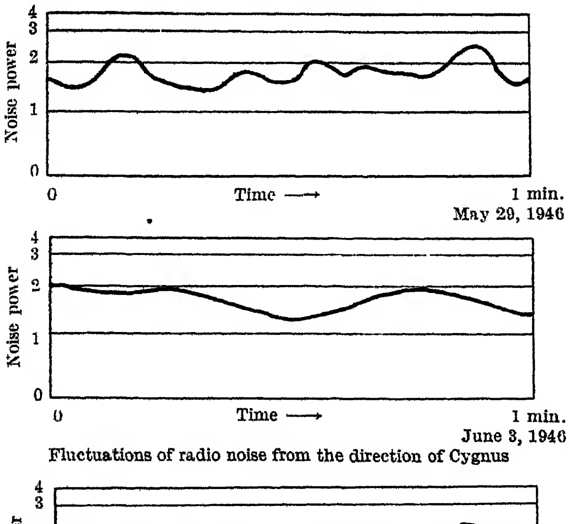
In a previous publication[1] we described the results of an investigation into the spatial distribution of cosmic electromagnetic noise radiation at 5 metres wave-length. We have recently been engaged in an attempt to make a more detailed determination by using a more sensitive receiver of narrower beam-width. An interesting new feature which has emerged from these latter experiments is the occurrence of short-period irregular fluctuations which have been found to be associated with the direction of Cygnus. This region, which is a secondary peak in the cosmic noise distribution, appears to be unique in being characterized by short-period variations of marked amplitude in the intensity of power flux.

A watch on this region has been kept intermittently during the last four months. The receiving apparatus, situated in Richmond Park, has an aerial beam rotatable in bearing but fixed in elevation at an angle of 12°. The region of the fluctuations ascended and descended through the aerial beam on bearings 30° and 330° respectively. The corresponding times were 0100 hr. and 1900 hr. G.M.T. in February, when the watch was commenced, while in June they were 1800 hr. and 1200 hr. G.M.T. Care was taken to avoid including recordings taken in daylight periods when the powerful solar noise emission associated with the great sunspot in February was also present. Since the observations covered a wide range of bearings and solar times, we were able to rule out the possibilities of terrestrial or solar causes, and the interpretation of the results was consistent only with an origin in the direction of Cygnus.

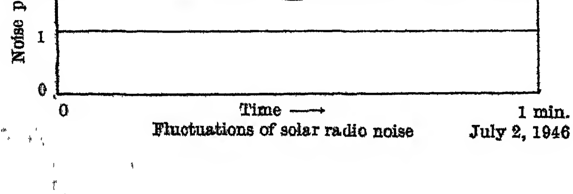
It is not easy to determine the bearing of a source of irregular disturbance with a high order of accuracy unless an exceptionally narrow beam is used. The aerial of the equipment has a beam width of approximately $\pm$ 6° to half power in bearing and elevation, and the average of a large number of observations indicated a source of disturbance subtending an angle not exceeding 2°. There may be other areas of occasional fluctuation in the immediate vicinity (within 8°).

The average amplitude of the fluctuation is 15 per cent of the mean power received. If the disturbed area be assumed to extend over a circle of angular diameter 2°, then this solid angle is 1/36 of that for the equivalent acceptance cone of the aerial beam. The variations in power per unit solid angle therefore correspond to more than five times the mean power per unit solid angle for the whole beam. The centre of the region is approximately R.A. 2000 hr., Decl. + 43°. The type of fluctuation, which itself varies from day to day, is illustrated in the accompanying figure. The noise from Sagittarius would, by comparison, appear as a straight line on a diagram of this scale.

It appears probable that such marked variations could only originate from a small number of discrete sources. This suggests at once the analogy with the radio-frequency sunspot radiation[2,3,4]. The solar radio noise from sunspots is also characterized by strong fluctuations. A recording of these solar radiations, taken on July 2, is also shown in the figure. On the other hand, Greenstein, Henyey and Keenan[5] have recently pointed out the difficulties in attempting to account for the magnitude of cosmic radiations in terms of the solar phenomena; further, they direct attention to the close agreement between experimental observations of cosmic noise intensity and their calculations of the expected interstellar radiation arising from free transitions of electrons in the field of protons. A theory in terms of widely distributed interstellar matter does not, however, appear readily to account for the localized disturbances just described. These fluctuations therefore appear of special importance in that they may prove particularly relevant to the explanation of the origin of cosmic radiations at radio frequencies.



Fluctuations of radio noise from the direction of Cygnus



Fluctuations of solar radio noise July 2, 1946

We are indebted to the Director General of Scientific Research and Development (Defence), Ministry of Supply, for permission to publish this communication.

J. S. Hey
S. J. Parsons
J. W. Phillips

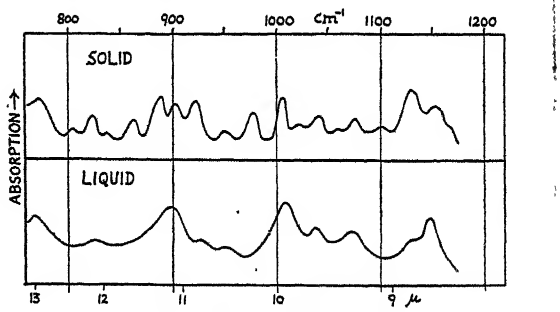
Ministry of Supply.
July 4.

[1] Hey, Parsons and Phillips, *Nature*, **157**, 296 (1946).
[2] Appleton, *Nature*, **156**, 534 (1945).
[3] Hey, *Nature*, **157**, 47 (1946).
[4] Pawsey, Payne-Scott and McCready, *Nature*, **157**, 158 (1946).
[5] Greenstein, Henyey and Keenan, *Nature*, **157**, 805 (1946).

Infra-Red Spectra and State of Aggregation

Recent work in this Laboratory has shown that the infra-red spectrum of a substance may differ markedly according to the particular state of aggregation—gas, liquid or solid—in which it is measured[1]. The interpretation of such changes has become especially significant in connexion with the correlation of spectra with molecular structure, particularly when dealing with polymers, resins and plastics; but the principles underlying the phenomenon are of fundamental importance and must involve a consideration of the degree of molecular order in the different states of aggregation.

In order to examine this phenomenon in greater detail, a survey is being made of the spectra of some simple molecules as solids and liquids. With polar substances the spectral differences found are not surprising, but they have also been found with a number of non-polar substances. For example, there are marked changes in the case of 3-ethyl tetracosane, the spectra of which between 8–13 μ are shown. It should be noted that not only do new bands appear with the solid, but there are some differences in relative intensity of bands in the two states, even though the frequencies may be little affected.



Spectra of 3-ethyl tetracosane

The extent to which the spectrum is affected by the change of state varies with the particular molecule concerned, and with branched paraffins, for example, appears to depend upon the extent and positions of branching. Similar measurements have recently been described by Halford and Schaeffer[2] with benzene, and substantially the general conclusions drawn by them appear to apply to results found for other hydrocarbons. As pointed out in an earlier paper[1], the passage from one physical state to another will involve a change in both the potential energy function of the system and of the selection rules, and with a long branched paraffin chain the frequencies and intensities of the bands may be expected to change.

Further examples of this phenomenon will be considered in detail later.

H. W. Thompson

Physical Chemistry Laboratory,
Oxford.
July 13.

[1] Thompson, H. W., and Torkington, P., *Trans. Farad. Soc.*, **41**, 259 260 (1945); *Proc. Roy. Soc.*, A, **184**, 15 (1946).
[2] Halford, R. S., and Schaeffer, O. A., *J. Chem Phys.*, **14**, 141 (1946). Halford, R. S., *J. Chem Phys.*, **14**, 8 (1946).

High-Frequency Resistance of Superconductors

Measurements by H. London[1] on the heating of superconducting tin by high-frequency electromagnetic fields indicate the presence in the superconductor of some mechanism which enables it to absorb a measurable quantity of energy from the field provided the frequency is of the order of 1,000 Mc./sec. or more. Recent developments in radio technique have made it possible to employ a resonance method to investigate the effect, and this communication describes preliminary work at frequencies around 1,200 Mc./sec., corresponding to a free-space wave-length of 25 cm. The specimens were polycrystalline thin wires contained in quartz capillary tubes for rigidity, bent into a narrow U

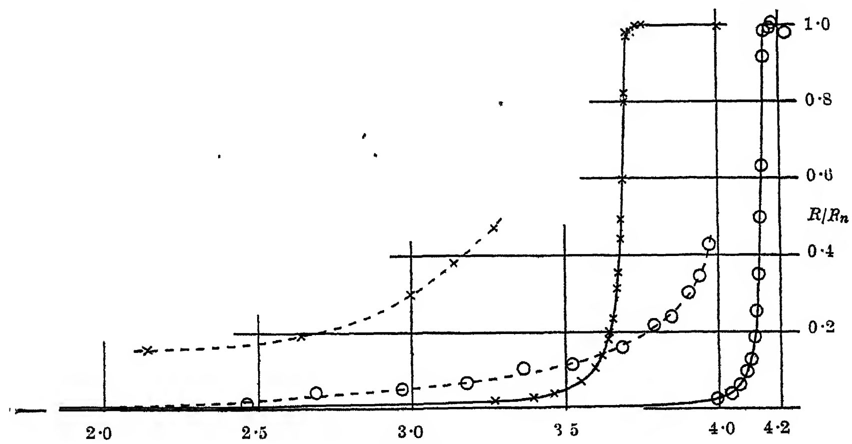
to form a twin transmission line roughly a quarter wave-length long, and surrounded, to eliminate radiation losses, by a cylindrical sheath, which was either silver-plated or lined with lead-foil to minimize resistive losses. Measurements of the width of the resonance curve of the system by a controlled variation of the oscillator frequency gave a value for the skin resistance of the specimen.

The accompanying graph shows the skin resistance R of tin and mercury, relative to its value R_n for the normal metal just above the transition point, as a function of temperature. The shape of the curve for tin is in good agreement with London's published curve, measured at the slightly different frequency of 1,500 Mc./sec.; there are no previous results with which to compare the curve for mercury. For both metals the curves appear to tend to zero at 0° K., though there is some uncertainty in the values of the skin resistance at the lowest temperatures, due to dielectric loss in the quartz, which limits the Q of the resonator to about 250,000. By comparing the results for two wires of different diameter, the dielectric loss may be estimated, and the curves here shown have been corrected for this effect as well as possible.

The absolute skin resistance of the specimen may be determined from the Q and the geometry of the resonator, and from this, by application of the standard theory of the skin effect, the specific conductivity of the metal can be deduced. The value obtained for normal tin at 3·8° K. was $2{\cdot}1 \pm 0{\cdot}2 \times 10^7$ ohm.$^{-1}$ cm.$^{-1}$ (the large probable error arises from the approximations used in performing the calculation rather than from the measurements, which were consistent within 1 per cent); a D.C. measurement of the specific conductivity gave 15×10^7 ohm^{-1} cm.$^{-1}$, more than seven times as great. A discrepancy of the same magnitude was noted by London. For mercury the effect is not so pronounced, the specific conductivity as deduced from the radio-frequency measurements being $0{\cdot}92 \times 10^7$, compared with the D.C. value[2] of $2{\cdot}1 \times 10^7$.

Although the shape of the specimen was not very suitable, an attempt was made to discover whether the skin resistance was affected by the presence of a constant magnetic field. Up to one half the critical field, no variation of skin resistance was detected, which by London's theory (see below) may be interpreted as evidence for the constancy of the penetration depth in small fields. No useful readings could be taken in stronger fields, since a portion of the specimen passed into the intermediate state.

The variation of the skin resistance of mercury with temperature is particularly interesting, since with the aid of London's[1] theory of the effect it is possible to deduce the variation with temperature of the penetration depth λ, which has been studied for mercury more directly by other methods; it is, however, too much to expect agreement with these other results, since they do not agree among themselves. Appleyard and his collaborators[3], from the properties of thin films, and Shoenberg[4], by measurements on colloids, found an increase in λ as the critical temperature is approached from below, whereas



O——O, mercury, R/R_n; O- - - -O, mercury, $R/R_n \times 20$;
×——×, tin, R/R_n; ×- - - -×, tin, $R/R_n \times 20$

Casimir[5], using a mutual inductance method with macroscopic specimens, found no such change. In order to apply London's theory to the radio-frequency measurements, it is necessary to assume only one parameter λ_0, the penetration depth at 0° K. Taking $\lambda_0 = 1{\cdot}0 \times 10^{-5}$ cm., as found by Appleyard *et al.*, the value of λ at any other temperature may be calculated to agree within 10 per cent with Appleyard's figures. It would be unwise to regard this agreement as very significant, in view of the assumptions involved in London's theory, which need to be tested by an extensive investigation of the behaviour of both normal metals and superconductors over a wide range of temperatures and frequencies.

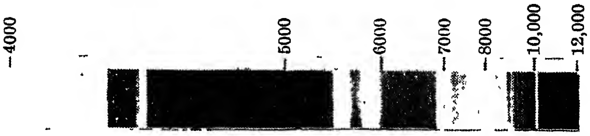
A. B. PIPPARD

Royal Society Mond Laboratory,
Cambridge.
July 22.

[1] London, H., *Proc. Roy. Soc.*, A, **176**, 522 (1940).
[2] Kamerlingh Onnes and Tuyn, "Intern. Crit. Tables", **6**, 124 (1929).
[3] Appleyard, Bristow, London, H., and Misener, *Proc. Roy. Soc.*, A, **172**, 540 (1939).
[4] Shoenberg, *Proc. Roy. Soc.*, A, **175**, 49 (1940).
[5] Casimir, *Leid. Comm.*, 261, *c* (1940).

Investigations of Near Infra-Red Radiations by Means of Image Converters

FOR rapid examinations of near infra-red light up to 15,000 A., image converters are very useful. Their main advantage lies in enabling one to 'see' immediately what infra-red sensitized plates show only after involved processing. The spectrum under test is projected on to a photo-electric cathode of the type (Ag) – Cs_2O, Cs, Ag – Cs. The number of photo-electrons released is proportional to the intensity of radiation on that particular part of the cathode; they are focused by an electronic lens and form a picture on the fluorescent screen, which can either be studied visually or photographed. The accompanying illustration shows a photograph (× 1·5) of the mercury spectrum. In addition to the visible lines a number of lines in the near infra-red part of the spectrum have appeared. On the original photographic plate we can also see some lines of longer wave-length, which cannot be seen on the reproduction.



It should be mentioned that the converter used had a convex cathode, so that only a part of the image could be focused; but it appears probable that, with an improved apparatus of this type, a number of important problems could be attacked.

A. VASKO

Physical Institute of Charles' University,
Praha II.
July 6.

Long Wave-length Absorption Bands of Aromatic Molecules

CALCULATIONS of the long wave-length absorption bands of aromatic molecules, such as those carried out by Sklar[1] and Förster[2], give good agreement with the experimental values of absorption maxima even when only nearest-neighbour exchange effects are taken into account (as in Förster's work). In these calculations, it almost always happens that the lowest two totally symmetric levels (of which the ground-state is one) are separated by an unsymmetric level, and the transition to this from the ground-state is permitted in molecules having, at most, twofold axes of symmetry: experimentally, the long-wave absorptions of these molecules have intensities compatible with an allowed transition—anthracene, for example, has $\varepsilon_{max.}$ of about 10^4.

Phenanthrene, however, provides an interesting departure from this usual situation. Here the energy-level calculation shows that there is no unsymmetric level between the ground-state and the lowest excited symmetric level, and consequently the transition of lowest energy is one between levels of the same symmetry. The usual symmetry considerations show that the transition moment for such a change will be very small and will lie along the axis of symmetry of the molecule. In fact, the absorption of phenanthrene does show a weak long wave-length absorption between 3000 A. and 3600 A., having its centre at about 3400 A., and with $\varepsilon_{max.}$ about 300. This band is comparable in intensity with the forbidden A_{1g}-B_{2u} transition in benzene (2600 A.) and is, apparently, to be associated with the symmetric-symmetric transition discussed above. Förster associated his calculated value of 3000 A. with the strong phenanthrene band at 2950 A.; it now appears that it should be assigned to the 3400 A. weak band, and that the 2950 A. band is due to a symmetric-unsymmetric transition of higher energy. The poor agreement between the calculated and experimental values for the forbidden transition is connected with the fact that Forster's empirical exchange integral was estimated as an average for a number of inter-symmetry transitions and is too large for a symmetric-symmetric change.

The above assignment receives confirmation from the fact that the 3400 A. band is greatly increased in intensity (× 10) when the C_{2v} symmetry is destroyed by the substitution of a nitrogen atom for a carbon atom, to give the skew benzquinolines. The situation is in marked contrast to the anthracene-acridine-benz-*g*-quinoline case where the transition moment (this is an allowed transition) is scarcely altered when the symmetry is lowered.

Further details, together with some related work, will be published soon.

D. P. CRAIG

Department of Chemistry,
University of Sydney.
July 10.

[1] Sklar, A. L., *J. Chem. Phys.*, **5**, 669 (1937).
[2] Förster, Th., *Z. Elektrochem.*, **45**, 548 (1939).

Mathematics in Government Service and Industry

In an article in *Nature* of May 4, p. 571, Mr. John Todd and Mr. D. H. Sadler expressed the view that training in numerical methods should be given to mathematical students at the post-graduate level. The chief reason given was that their experience had shown that a knowledge of the more advanced parts of mathematics often becomes a powerful tool in the hands of the computer. The object of this note is to direct attention to an example which arose recently in connexion with my research work, providing additional evidence for their views.

In the course of a certain investigation, it was necessary to tabulate the function given by the doubly infinite series,

$$\sum_{r=1}^{\infty}\sum_{s=1}^{\infty}\frac{\sin\,(2r-1)\pi\alpha/a\,.\sin\,(2s-1)\pi\beta/b}{(2r-1)\,(2s-1)\,[(2r-1)^2b^2+(2s-1)^2a^2]}\qquad(1)$$

where $a = 160$, $b = 60$ for a range of values of α and β given by $\alpha = 5{\cdot}0,\ 6{\cdot}0,\ 7{\cdot}0,\ 8{\cdot}0,\ 9{\cdot}0,\ 10{\cdot}0$; $\beta = 0{\cdot}6,\ 0{\cdot}7,\ 0{\cdot}8,\ 0{\cdot}9,\ 1{\cdot}0,\ 1{\cdot}1$.

Consider the direct computation from (1) for the values $\alpha = 5{\cdot}0$, $\beta = 0{\cdot}6$. After considerable numerical computation, it was shown that the sum of the first hundred terms of the doubly infinite series (corresponding to $1 \leqslant r \leqslant 10$, $1 \leqslant s \leqslant 10$) evaluated to 3·528. However, the series converged so slowly that even with this amount of laborious calculation little accuracy could be expected.

It may be shown, however, by a method the details of which I hope to publish elsewhere, that one of the double series may be summed, and the expression reduces to

$$\pi/4a^2\sum_{s=1}^{\infty}\frac{\sin\,(2s-1)\pi\beta/b}{(2s-1)^3}\,[1-\cosh\,(2s-1)\pi\alpha/b$$

$$+\coth\,(2s-1)\pi a/b\,.\sinh\,(2s-1)\pi\alpha/b-\sinh\,(2s-1)\pi\alpha/b\,.\,\mathrm{cosech}\,(2s-1)\pi a/b]\quad(2)$$

Moreover, for the given values of a and b, correct to at least five places of decimals, $\coth\,(2s-1)\pi a/b$ is equal to unity. With this simplification, the expression may be shown to reduce to

$$\frac{\pi^4\beta}{32a^2b}\left[1-\beta/b\right]-\frac{\pi}{4a^2}\sum_{s=1}^{\infty}\frac{\sin\,(2s-1)\pi\beta/b\,.\exp\,[-(2s-1)\pi\alpha/b]}{(2s-1)^3}\quad .\ .\ .\ (3)$$

I have been unable to complete the summation contained in (3), but the series converges sufficiently rapidly for a good approximation to be obtained from consideration of the first ten terms. For the particular case $\alpha = 5{\cdot}0$, $\beta = 0{\cdot}6$, expression (3) gives a value 3·92 which differs appreciably from the value 3·528 found by the much more laborious method of direct computation. As it was required to evaluate the expression for the range of values of α and β, the total time saved was considerable.

This example shows that a knowledge of the more advanced parts of mathematics may be extremely useful in problems of numerical computation, and confirms the views previously expressed that training in numerical methods suitable for candidates proposing to make a career in the Scientific Civil Service should be given at the post-graduate level.

T. J. Willmore

306 Bedford Road,
Kempston, Beds.
June 25.

Combustion of Carbon and Carbon Monoxide

The recent observation of Arthur[1], who found that the $CO/(CO + CO_2)$ ratio in the products of combustion of carbon in air at 800° C. was greatly increased by addition of chlorine or its compounds, is extended by results obtained in these laboratories during the past six months. We have worked at 800°–1,000° C. with undried gases, and find that:

(i) In the combustion with air of 18-in. deep beds of 1 mm. particles of coke in a 1-in. silica tube, the $CO/(CO + CO_2)$ ratio in the exit gas is increased by the addition of small amounts of chlorine, hydrogen chloride, or carbon tetrachloride to the air. Thus at 1,000° C. and with an inlet total gas rate of 200 litres/hr., sufficient to expand the bed of coke particles to a voidage of 0·7 so that the whole bed was agitated, the exit gas analyses (not quenched) were

% Vol.	Carbon tetrachloride	Carbon dioxide	Oxygen	Carbon monoxide	$CO/(CO+CO_2)\times 100$
	Nil	16·8	Nil	4·8	22·0
By	0·2	13·0	0·8	10·4	44·0
Orsat.	0·4	9·6	0·2	17·0	64·0
	2·0	3·2	0·2	29·5	90·0

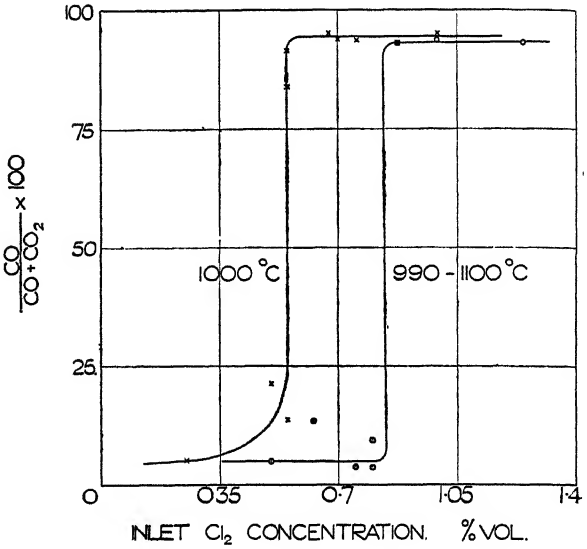
The 3·2 per cent carbon dioxide in the table probably contained nearly 2 per cent free chlorine. The temperature was measured by a thermocouple placed in the centre of the tube, 2–4 in. from the top of the coke.

(ii) The above effect is not due to catalysis of

$$CO_2 + C \rightarrow 2CO,$$

since no change in gas composition occurs when chlorine is added to carbon dioxide passed through coke under the same conditions.

(iii) In the combustion of 10 per cent carbon monoxide in air plus nitrogen mixtures (O_2/CO ratio = 1) over 18 in. of silica chips in a 1-in. silica tube, almost complete inhibition can be obtained by addition of chlorine. At any temperature there is a critical chlorine concentration at which inhibition sets in (see graph). This critical concentration increases with temperature, and for a given concentration of inhibitor there is a critical temperature above which no inhibition occurs.



All the chlorine is not found as such in the product gases when inhibition is occurring, and there are indications that only the excess chlorine above the critical concentration for inhibition appears in the exit.

An interesting aspect is an inhibition-temperature hysteresis effect. Starting with a carbon monoxide air mixture containing chlorine slightly less than its critical concentration, it is found that inhibition commences and becomes complete on lowering the temperature, but does not cease when the temperature is then raised above that at which it commenced. Inhibition ceases, however, if the flow of the inhibitor is momentarily interrupted.

Both this hysteresis effect and the critical chlorine concentrations effect can be explained on a chain-theory basis[2,3], assuming the inhibiting action of chlorine is due to combination with an active link in the chain process. Lowering the temperature reduces the degree of chain branching until the inhibitor present is equivalent to the active links, when oxidation ceases and inhibition is complete; but once inhibition has started, combustion cannot occur even at higher temperature as the inhibitor is present in sufficient quantity to prevent the initiation of the process before branching (and therefore combustion) can begin. The residual carbon dioxide in the inhibited oxidation gases (0·5–0·7 per cent carbon dioxide), which is shown in the graph by the non-achievement of 100 per cent inhibition, may be significant, as it has possibly been formed by the direct non-chain oxidation of carbon monoxide.

Applying these observations on the oxidation of carbon monoxide to the earlier work on coke combustion some conclusions can be drawn. The very low carbon dioxide content of the gases produced by the inhibited combustion of coke would suggest that carbon dioxide is not formed as a primary product in the oxidation of carbon at 1,000° C., the monoxide being the first gas formed, which in normal (uninhibited) combustion processes is immediately oxidized to the dioxide in the voids of the bed. This secondary carbon monoxide oxidation reaction does not occur when the inhibitor is present. From other experiments, it is apparent that the effect of the voidage of the bed on the combustion reaction is considerable. Working with a highly expanded bed (under conditions somewhat similar to those in Chukhanov's experiments[4,5] with a suspension of carbon in air) a gas is produced with a low CO/CO_2 ratio, while with a bed of smaller voidage the carbon monoxide content is increased at the expense of the dioxide, at least partly due to an increase in the extent to which the dioxide reduction reaction can take place. This suggests that the character of the combustion gas is controlled to a very large extent by conditions in the bed above the combustion zone, where the reduction of carbon dioxide is the predominating reaction, rather than in the combustion zone itself[6,7,8].

It is hoped to give an account of these and further experiments to the Society of Chemical Industry at Newcastle early in 1947.

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Heat of Sublimation of Carbon

Long and Norrish emphasize in a recent communication[1] the importance of the tetravalent ^5S state of the carbon atom from the point of view of organic chemistry, stating that neglect to distinguish between divalent and tetravalent atomic states of carbon is mainly responsible for the apparent state of confusion characterizing at present the thermochemistry of carbon. It may be mentioned that Schmid and Gerö take a similar view in the thermochemical interpretation of their results concerning the spectrum of CO, when they deduce 170 kcal./gm.-atom as the heat of sublimation into ^5S atomic states of carbon[2].

According to the dissociation scheme given by Schmid and Gerö, the energy distance of the $X^1\Sigma$ ground state of CO from the $C(^5S) + O(^3P)$ atomic term combination is 11·06 eV. (with the original conversion factors), and this energy value is to be taken into account in thermochemical calculations involving tetravalent carbon compounds, or in determining the heat of sublimation of carbon. In CO, carbon is divalent, the ground-state dissociating accordingly into an atomic term combination corresponding to a carbon state of the s^2p^2 configuration, probably into $C(^1D) + O(^1D)$, the bond energy of CO ($X^1\Sigma$) being in this case 10·1 eV., while for the energy distance of the CO ground-state from the lowest $C(^3P) + O(^3P)$ atomic term combination gives 6·89 eV. Unfortunately, these results have often been misunderstood, in calculating the heat of sublimation of carbon from this last dissociation energy value, whereas the heat of sublimation of carbon is connected with the value corresponding to carbon atoms in the ^5S state. The spectroscopic value 170 kcal. is in excellent agreement with the dynamic sublimation heat value resulting from the rate of loss in weight of heated carbon filaments, while the lower value resulting from an equilibrium measurement in the carbon arc can be interpreted by a statistical equilibrium between C atoms and C_2 molecules[3].

Meanwhile, several authors have arrived at the conclusion that the heat of sublimation of carbon should be 170 kcal. Thermochemical considerations of White[3], the reconciliation of some kinetic and thermochemical data by Baughan[4], the conclusions of Kynch and Penney[5] from absorption bands of mesomeric hydrocarbons, and the recent note of Sidgwick and Springall[6] concerning the Hg—C bond all point in this direction. According to the interpretation of Schmid and Gerö, the corresponding conclusions can be maintained or suitably re-interpreted in taking into account that the organic compounds dealt with are built up from tetravalent ^5S atoms, and the bond energies are to be calculated from an energy value corresponding to the ^5S term of carbon.

Against the dissociation scheme of CO given by Schmid and Gerö, Herzberg puts first of all as a theoretical argument the non-crossing of the energy curves of the two-centre problem, and applies this argument also to the sublimation of carbon in deducing the formation of ^3P carbon atoms[7]. But as can be shown[8], the conclusions resulting with respect to the energy curves of the two-centre model cannot be transferred to the potential curves of the vibrating and rotating molecule, the electronic motion (the averaging with respect to which of the interactions between all the particles leads to the potential curve determining the motion of the nuclei) also being influenced through the interaction by the motion of the nuclei. The co-ordination of Schmid and Gerö is supported by a large number of arguments in their paper, among the more recent results being an observed predissociation limit at 8·83 eV.[9], and the convergence of the $I^1\Sigma$ state to 10·1 eV.[10]. According to still unpublished calculations of Gerö, the resulting value of the heat of sublimation of carbon can give a satisfactory account of a great variety of thermochemical data of organic compounds.

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WHILE agreeing with our emphasis of the significance of the ^5S state of carbon for the calculation of bond energies in its compounds, Valatin, from an analysis of the CO spectrum proposed by Schmid and Gerö, implies alternative numerical values to the quantities which we have termed L_1 and L_2[1], and for which we have proposed the values 125 and ~ 190 kcal./gm.-atom respectively. The scheme quoted by Valatin would mean in effect that $L_1 = \sim 73$ kcal. and $L_2 = 170$ kcal., values which are in serious conflict with other relevant data. It should be emphasized that, since more than one interpretation may be devised for the CO spectrum, spectroscopic arguments alone lead to no conclusive value for D(CO) and hence L_1. Only a consideration of the spectroscopic data with all the evidence available from other sources will allow a final selection to be made.

Direct or indirect measurements of the vapour pressure of graphite by both the equilibrium and dynamic methods have, in the past, led to varying results for the heat of sublimation, some as high as 200 kcal. or more. In general, the determination of the vapour pressure under equilibrium conditions provides considerably lower figures for the heat of sublimation than does the dynamic method; and the equilibrium method alone (after a statistical allowance for the pressure of C_2 molecules has been made) is capable of providing a direct measure of L_1. Whereas some determinations, in particular the approximate equilibrium measurements of Thiel and Ritter[2] and Basset[3], have indicated values for L_1 so low as about 125 kcal., none has provided values appreciably lower than this figure. For conditions under which true equilibria have been established, equilibrium concentrations of both free carbon atoms in their ground (^3P) state and C_2 molecules must be considered, and we do not regard as justifiable Schmid and Gerö's effectual neglect of the ^3P atomic state in carbon vapour[4] in their discussion on the results furnished by the equilibrium method. The precise value of $D(C_2)$ is unfortunately not settled: whereas one estimate places it so low as 83 kcal./mol., it may be so high as 150 kcal., but could scarcely be appreciably higher than this figure.

The theoretical total vapour pressure values for carbon with the intermediate assignment $D(C_2) = 125$ kcal. have been calculated by Goldfinger and Jeunehomme[5]. The highest reasonable assumption regarding $D(C_2)$ could not reconcile the observed pressures with a value of L_1 much below 125 kcal., and since these authors further demonstrate that even $L_1 = 107$ kcal. necessitates a vapour pressure much too high to be a likely value, it is still more difficult to accept the much lower value (~ 73 kcal.) implied by Schmid and Gerö's analysis, which requires vapour pressures several powers of ten greater than have ever been observed. Furthermore, the low value 6·9 eV. for D(CO), from which this figure is derived, finds no place in the empirical relationship for similar diatomic molecules observed by Barrow[6], which necessitates a dissociation energy for CO in the neighbourhood of 9 eV.

From the point of view of bond energies, L_2 is by far the more interesting quantity. Theoretical considerations[7] have led to the expectation that the mean bond energy in the methyl radical is slightly greater than in methane. From the heat of formation of methane, the dissociation energy of H_2, and the energy required to remove a hydrogen atom from the methane molecule[8], it can be shown that the mean bond energy in CH_3 will exceed that in CH_4 only if $L_2 > 182$ kcal. This, and other considerations regarding the relative energies of reorganisation of methyl and ethyl radicals on their formation from methane and ethane respectively, lead us to ~ 190 kcal. for L_2. This figure is also to be preferred from the calculation of the heat of sublimation (177 kcal.) by the dynamic method[9], since it would follow from the arguments of Herzberg[10] that this method provides only a lower limit for L_2.

That the inferred figure, ~ 65 kcal., for the difference between L_2 and L_1, that is, the excitation energy of ^5S carbon, is to be preferred to the value ~ 97 kcal. (favoured by Schmid and Gerö) is strongly indicated by three independent lines of thermochemical evidence which are discussed at length in our forthcoming paper[11]. These include experimental data regarding the stability of the formyl radical, which place an upper limit of about 75 kcal. on the C : ^5S excitation energy. In accord with this, a calculation by Ufford[12] places this excitation energy at ~ 73 kcal.

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A 'New' Human Blood Group Antigen of Frequent Occurrence

THE sera of two women, whose babies were suspected of suffering from hæmolytic disease of the new-born, were recently found to contain identical agglutinins of a variety not previously described. The serological examination of the two families is at present incomplete, but there is so far no definite evidence in either case that the agglutinin concerned is the result of immunization of the mother by the fœtus. Indeed, the red cells of one of the jaundiced babies were not agglutinated by its mother's serum: this points towards the agglutinin being spontaneous rather than immune.

The antibodies are active at 37° C.; they appear slightly stronger at room temperature: at 10° their effects are masked in both cases by strong non-specific cold agglutinins. Both the women are of group *O* and the α- and β-agglutinins are difficult to absorb from the sera without diluting out or removing most of the 'new' agglutinin. Hence nearly all examinations have been carried out on group *O* red cells.

Out of 96 group *O* bloods of English people, mostly unselected but some selected for their *Rh* type, 24 (or 25 per cent) are agglutinated. Reactions are mostly well-defined positive and negative; one doubtful result has been eliminated from this count, and it is possible in view of the weakness of the antibodies that some positives have been missed.

The 'new' agglutinogen has been shown to be independent serologically of the *ABO*, *MN*, *Rh*, *P* and Lutheran[1] systems. It is also independent of the 'Kell' system, which was shown to be responsible for a case of hæmolytic disease of the new-born—case No. 14 of Coombs, Mourant and Race[2]. By kind permission of Mrs. H. D. G. Lewis, who has the 'new' antibody, and of her husband, the name 'Lewis' is proposed for the antigen.

Fifteen families have been studied from the point of view of the inheritance of the agglutinogen. In seven cases both parents of a Lewis-positive person have been examined. In every case at least one of them is also positive. This is conclusive evidence that the agglutinogen is inherited, and suggestive, but not statistically significant, evidence that it is a Mendelian dominant character rather than a recessive. No evidence has yet been found of genetic linkage with other blood group antigens.

Cells agglutinated by the antibody form characteristic large rather loose masses. Lewis-positive cells which have been treated with a barely agglutinating dose of antibody and washed are not agglutinated by anti-human-globulin serum[3]. The antibody thus differs from the *Rh* antibodies and apparently resembles in this respect the iso-agglutinins α and β [2].

I should like to acknowledge the assistance which I have received from Mr. R. Hudson of the N.E. London Blood Supply Depot, Luton, who first found and directed my attention to these antibodies, and from Dr. R. R. Race. A full account of the investigation will be published elsewhere.

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Combined Action upon Muscle of Adenosine Triphosphate, Acetylcholine and Potassium, Calcium and Magnesium Ions

IN a note published in *Nature* in 1944, Buchtal and Kahlson[1] have pointed out that the close intra-arterial injection of 5 μgm. acetylcholine after introduction of adenosine triphosphate increases the intensity and duration of the mechanical response of muscle. The combined action of these substances is of considerable interest, in view of the important part taken by adenine triphosphate in muscular contraction and of the participation of acetylcholine in the transmission of impulses at the myoneural junction.

Our experiments have been carried out with the dorsal muscle of the leech and the m. rectus abdominis of the frog. The muscles were placed in Ringer solution of the following composition: sodium chloride, 6·0 gm.; potassium chloride, 0·14 gm.; calcium chloride, 0·06–0·1 gm.; sodium bicarbonate, 0·1 gm.; and water, 1 litre. The sodium salt of adenosine triphosphate was prepared immediately before the experiment and used in concentrations of 1×10^{-5} – 1×10^{-4} with frog muscles and in concentrations of 2×10^{-4} – 1×10^{-4} with dorsal leech muscles.

It was found that these concentrations of adenosine triphosphate did not by themselves produce any contraction of the m. rectus abdominis of the frog, and they led to small contractile response of the leech muscle. After one application of the adenosine triphosphate solution the frog and leech muscles react to solutions of acetylcholine with contractions of increased intensity. The contractions remain increased when the solution of acetylcholine is applied several times. It follows that adenosine triphosphate sensitizes the muscle to acetylcholine. The initial smaller contractile effect of acetylcholine is restored only after repeated washing of the muscle with Ringer solution.

In another series of experiments, we investigated the contractile response of muscle to the action of adenosine triphosphate and acetylcholine in different ionic media.

These experiments were undertaken in view of the fact that potassium, calcium and magnesium ions influence the activity of adenosinetriphosphatase[2–5] and the contraction of myosin threads[6,7]. According to these data, calcium ions activate adenosine triphosphatase, thereby promoting its breakdown, and potassium and magnesium ions inhibit adenosine triphosphatase, thereby counteracting the breakdown of adenosine triphosphate. On the other hand, it has been shown that the contraction of myosin threads produced by adenosine triphosphate in the presence of potassium chloride is inhibited by calcium ions and increased by potassium and magnesium ions.

To determine the effect of changed ionic environment we have used Ringer solution with increased contents of calcium chloride (up to 0·3 gm. in 1 l.) or of potassium chloride (up to 0·28 gm. in 1 l.); in some experiments magnesium chloride was added to the Ringer solution (0·1 gm. to 1 l.). The increased concentration of potassium ions leads to a markedly increased reaction to acetylcholine of muscles subjected to the action of adenosine triphosphate. This increased sensitivity to acetylcholine persists longer than in normal Ringer solution. The same effect is obtained in the presence of magnesium ions.

The opposite effect was observed under the influence of calcium ions. When their concentration in the solution is increased, adenosine triphosphate does not cause contraction of the dorsal muscle of the leech; sensibilization to acetylcholine was also absent, and the muscle was less responsive to it. Both in the frog muscle and in that of the leech adenosine triphosphate produces no contraction in Ringer solution with increased content of calcium, and leads to a persistent decrease of the contractile response to acetylcholine.

Our data on the action of potassium, magnesium and calcium ions upon the contractile response of muscle produced by adenosine triphosphate coincide with the results obtained by Szent-Györgyi and Erdős with myosin threads. They show that the action of ions upon adenosine triphosphatase and their action upon contractility of muscle are two separate and not directly parallel processes.

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Role of Thiamin and Riboflavin in the Biosynthesis of Vitamin C

THE rat is known to synthesize vitamin C in the course of its normal metabolism. It has been observed by Longenecker and associates[1] that this synthesis can be greatly stimulated, resulting in the high urinary excretion of the vitamin, when the rats are given daily a variety of compounds, particularly narcotics. In view of the great variation in the nature and constitution of the effective compounds, these authors are inclined to the view that these substances act as promoters rather than precursors for the synthesis of the vitamin. They were not able to suggest, however, any probable mechanism for this biosynthesis of vitamin C by narcotized rats.

It has been observed by us that narcotics such as chloretone stimulate the synthesis of vitamin C in rats without significantly affecting urinary sugar, nitrogen and phosphorus, blood sugar and phosphorus and liver glycogen. Injection of intermediary metabolites such as pyruvate, lactate, etc., into rats has no effect on the synthesis. The process has also been found to be independent of certain endocrine factors, as the excretion under the narcotic remains unaffected by adrenalectomy or pancreatectomy.

Different dehydrogenase systems such as citric, glutamic, glycerophosphoric, succinic, glucose, lactic and pyruvic, present in rat tissues, have been studied by the methylene blue technique. It has been observed that pyruvic and lactic dehydrogenases are affected in the chloretonized condition of the animals. The effect of chloretone on the aerobic and anaerobic oxidation of pyruvate by brain tissue of the rat under normal and narcotized conditions of the animals has been studied by the Warburg manometer and by the ferricyanide technique of Quastel *et al.*[2] respectively. A definite inhibition of pyruvic acid oxidation has been observed under aerobic condition, the effect being far less pronounced in the anaerobic state. This seems to indicate, as also suggested by Michaelis *et al.*[3], that chloretone exerts its main effect on that part of the system which is responsible for the oxidation of pyruvic acid under aerobic condition, and not on the components capable of oxidizing it anaerobically.

Following up this study further, it has been observed that the stimulating effect of chloretone on the biosynthesis of vitamin C by the rat and the consequent urinary excretion of the vitamin can be almost completely suppressed, if the animals are made thiamin-deficient. This stimulating effect can be restored to the deficient animals by thiamin therapy. The effect of inanition for one day each week, the sparing action of fat on thiamin and the possibility of vitamin C being destroyed during the abnormal state of vitamin B_1-deficiency of the rats have also been considered. It has been observed that the stimulating influence of chloretone on the synthesis of vitamin C by the rat is not affected by these conditions of the animals. It appears therefore that thiamin has some specific role in the synthesis of vitamin C by the rats under chloretone, and that the inhibition of pyruvic acid oxidation by the narcotic is very probably also a factor involved in the process.

It has further been found that the stimulating effect of chloretone on the synthesis of vitamin C and its urinary excretion by the rats can also be greatly suppressed if the animals are made riboflavin-deficient. The excretion of the vitamin can be restored to the original level by administering riboflavin to the deficient rats. It has also been shown by the paired feeding technique that inanition does not affect the role of riboflavin in this synthesis of ascorbic acid by chloretonized rats.

Barron *et al.*[4] have shown that thiamin or its phosphorylated form diphosphothiamin is closely associated with pyruvic acid metabolism in the living organism. Ball[5] has presented evidence for a scheme of pyruvic acid metabolism in which both thiamin pyrophosphate and flavoprotein are involved. From the present work it would appear that if pyruvic acid is transformed into ascorbic acid in the narcotized rat, this process also requires the participation of thiamin and riboflavin.

Our thanks are due to Dr. S. Banerjee for the surgical operation of some animals in connexion with the investigation. We are also indebted to the Indian Research Fund Association for a grant. Grateful acknowledgment is also made to Messrs. Hoffmann–La Roche, New Jersey, for the gift of the vitamins used in this work.

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Production of Potent Botulinum Toxins and Formol-Toxoids

THE preparation of suitable botulinus vaccines requires the production of toxin of great potency and high antitoxin combining power. The process of detoxication with formalin is facilitated if the medium is low in inactive proteinaceous substances. One of us (A. P.) suggested growing botulinus in 'Cellophane' bags filled with saline and immersed in meat broth (broth with meat particles). The bacilli grew readily in the bags and gave a very high yield of toxin. 'Cellophane' bags that contained nutrient broth instead of saline gave little toxin.

A 'D' type strain grown in saline in 'Cellophane' bags gave a culture of which 10^{-8} c.c. killed a mouse. The Lf and L+ were about eighty times those found with cultures grown in the ordinary way. The filtrate was readily detoxicated in 7–10 days with 0·5 per cent formalin, as against the three weeks needed by toxoid cultures made in meat

broth, even when 0·8 per cent formalin was used. The loss in antigenicity during preparation of the toxoid (measured by flocculation) was about half that usually found.

Guinea pigs immunized with a single dose of 1/40 c.c. of the new toxoid showed after a month a mean serum titre of 80 laboratory units. This compares with an average of 20 units obtained by immunization with 0·5 c.c. of ordinary toxoid. In practice, 0·5–1 unit of circulating antitoxin adequately protects a bovine against natural botulism (lamsiekte).

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Cyclic Variations of the Submicroscopic Structure of the Cortical Layer of Fertilized and Parthenogenetic Sea Urchin Eggs

The cortical layer of the unfertilized egg of *Psammechinus miliaris* exhibits a remarkable positive birefringence (with respect to the radial axis) which has been interpreted as meaning that the cortical layer is built up of radially arranged lipid molecules[1,2]. The birefringence disappears at fertilization and reappears during the anaphase of the first mitosis[3]. This means that the cortical layer undergoes rhythmic variations of its submicroscopic structure. We have investigated the cycle of such structural variations in relation to the phases of mitosis and to the modifications of permeability occurring during the early stages of development, in both fertilized and parthenogenetic eggs.

Birefringence totally disappears immediately after fertilization as well as after butyric acid treatment. It reappears, in both cases, about 10–15 min. later ($t° = 15°–18°$), but rather faintly and inconstantly. Between 15–20 min. and 50 min. after activation, the cortical layer is isotropic. It shows again a beautiful and very brilliant positive birefringence with polarization cross, from 50 min. to 1 hr. after activation, corresponding to the ana-telophase of the first mitosis in the fertilized eggs and to maximum expansion of the monaster in the parthenogenetic eggs.

Later on, the birefringence disappears when the first cleavage begins, and the monaster in the parthenogenetic eggs is undergoing reduction. At about 1 hr. 30 min., the cortical layer again shows birefringence, corresponding to the ana-telophase of the second division and to the expansion of the second monaster cycle.

The question arises whether the rhythm of the structural variations of the cortical layer is dependent upon the spindle cycle. Colchicine treatment, which inhibits spindle formation as well as the appearance of the spermaster in fertilized eggs and of the monaster in parthenogenesis, does not alter the rhythm of birefringence. Thus the birefringence cycle, although normally synchronous with spindle and monaster expansion, is entirely independent of them.

Two types of plasmolysis have been described in the fertilized and parthenogenetic eggs, following treatment with hypertonic sea water, indicating different physical conditions of the cortical layer: a 'smooth' and an 'angular' plasmolysis[4]. In the first case the egg contracts, preserving its spherical form; whereas in the second it acquires a wrinkled surface. We found that smooth plasmolysis occurs when the cortical layer shows birefringence (both in normal and in colchicine treated eggs); angular plasmolysis corresponds exactly to the phases of absence of birefringence.

A discussion of these findings will be published later in a more extensive paper.

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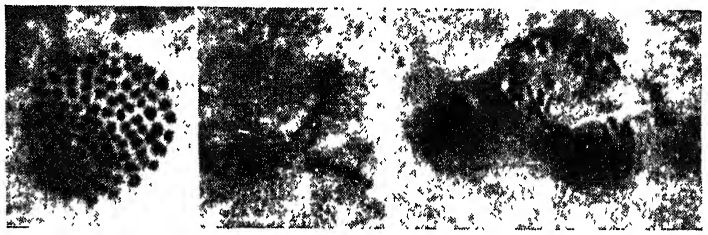
A Decaploid Strain of *Artemia salina*

On March 8, 1946, Dr. M. Levy, a chemist in the Palestine Potash Company at the north end of the Dead Sea, handed us a number of living specimens of the brine shrimp (*Artemia salina*) which he had found in abundance in the salt-washing pans of the potash works. In these pans the salt residue of Dead Sea water is washed out by admitting fresh water from the Jordan. This water gradually increases in salinity, but the various ions are represented in this solution in proportions differing from those of Dead Sea water. Especially, the magnesium concentration is relatively much lower than in the Dead Sea. At the time of collecting, the specific gravity of the water measured at 20° C. was 1·173 (potassium chloride 4·2, sodium chloride 22·0, calcium chloride and magnesium chloride 37·2 gm./l.; total of chlorine, 165 gm./l.).

It must be assumed that we have here an invasion of *Artemia* into a relatively new artificially produced biotope. The specific gravity of the water in this new locality is higher than that of the most concentrated solutions in which Gross[1] was able to keep his brine shrimp. On transferring the animals into Dead Sea water, they were found to survive no longer than six hours. *Artemia* is known to occur in Palestine at a distance of some 120 km., in the marine salt pans of Atlit, near Haifa.

Some of the animals, which were exclusively parthenogenetic females, were fixed in Carnoy's fluid. The chromosome number was determined as usual, in metaphase plates of the first oocytes. Of five specimens so far examined, one showed 107, two 108 and two 109 tetrads. Since the basic haploid number of *Artemia salina* is known to be 21, the present race must be considered as decaploid with a slight augmentation of the number of 105 tetrads. This deviation from the expected number may be interpreted in two possible ways. On one hand, there may be two to four supernumerary chromosomes fluctuating in the population. On the other hand, the deviation from the number of 105 tetrads may be due to failure of prophase pairing in some homologues. We might be dealing with 103 tetrads and 4 dyads, or with 102 tetrads and 6 dyads, or with 101 tetrads and 8 dyads. It is not impossible that polysomy and failure of pairing may be jointly responsible for the abnormal numbers observed. It should be noted that wherever details could be distinguished, the metaphase figures presented the aspect of tetrads. Among the specimens investigated, several had been fixed immediately after their arrival in the laboratory, others had been kept up to six weeks in various concentrations of Mediterranean sea water.



1 2 3

Fig. 1. First oocyte, Dead Sea strain, metaphase plate. 109 tetrads. Heidenhain's Hx. × *c.* 1250

Fig. 2. Multipolar first cleavage figure parthenogenetic egg, Dead Sea strain. In accordance with the three centres present, the chromosomes have become arranged in a triradiate figure. Heidenhain's Hx. × *c.* 950

Fig. 3. First cleavage figure, parthenogenetic egg, Dead Sea strain. Owing to the presence of four centres, a complicated multipolar spindle is formed, the left-hand part of which is seen in side view, the right-hand part in equatorial view. Heidenhain's Hx. × *c.* 1100

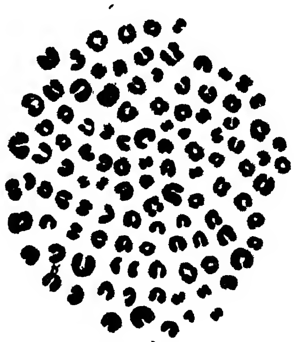


Fig. 1*a*. Camera lucida drawing of plate shown in Fig. 1. × *c.* 2400

Of a culture of parthenogenetic female brine shrimps collected in Atlit and kept for several years in the laboratory, some animals were fixed for comparison. In two of the individuals examined so far we have found 64 tetrads, a number which may be interpreted as hexaploid increased by one supernumerary pair.

Peculiar irregularities were observed in the first cleavage divisions of the Dead Sea strain. Owing to the formation of multipolar and quite irregular spindles, the chromosomes arrange themselves in equatorial plates at various angles to one another and appear to become distributed at random to the first blastomeres. The formation of these multipolar spindles may be caused by the abnormally high concentration of one or several of the ions present in the brine in which the strain was found. It might also be correlated with the exceptionally high grade of polyploidy, which is the highest so far found in Artemia[2].

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ARE HYDRANGEA FLOWERS UNIQUE ?

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APART from *Meconopsis betonicifolia* and *Hydrangea macrophylla*, no plant has been recorded as displaying a flower colour change, caused by varying soil conditions. That such a plant might exist is a possibility depending on three conditions[1,2]: (1) it must have a delphinidin flower pigment which in an acid cell sap is normally pink but is blue in the presence of excess aluminium; (2) it must be able to accumulate aluminium; this is a specific characteristic manifest only when sufficient is available, for example, in acid soils; (3) it must have a wide range or reaction tolerance. Many plants fulfil the first condition but invariably fail the rest. If a blue-flowered plant could be found that also accumulates aluminium, then there is a possibility that if such a plant could be grown in a neutral or slightly alkaline soil and so be unable to accumulate this element, a change of flower colour from blue to pink would take place.

Of the fifty-eight flowering plants hitherto known with certainty to accumulate aluminium in large amounts[3,4,5] none has blue flowers, but royal blue pigmentation does occur in the fruit of certain species of the well-known aluminium plant family, Symplocaceæ. In an examination for the presence of excess aluminium in several other blue-fruiting calcifuges, those hardy in Britain gave negative results[3]; but all except one, in Trinidad, provided they were dicotyledonous, gave highly positive results. Many common species of Melastomaceæ (not known to me at the time to be an aluminium-accumulating family) and Rubiaceæ with ultramarine fruits proved very strong aluminium-accumulators. To date, fifty-five blue-fruited dicotyledons have been found to give positive aluminium reactions. These belong to the following genera:

Symplocaceæ	3 Symplocos*[4].
Melastomaceæ	1 Leandra*, 3 Platycentrum*, 6 Clidemia*, 2 Conostegia[4], 9 Miconia*[4], 2 Ossea*, 1 Memecylon*[4].
Rubiaceæ	4 Coccocypselum*, 2 Faramea*, 7 Cephælis*, 10 Psychotria, 1 Palicourea*, 1 Rudgea*, 2 Saprosma*, 1 Lasianthus[4].

An examination of all the available members of the last two families disclosed that the capacity to accumulate aluminium is, so far as can be ascertained, most strongly developed in the more advanced of the woody tribes, namely, the Coussareæ and Psychotrieæ in the Rubiaceæ and the Miconiæ and Memecylieæ of the Melastomaceæ. Other genera, hitherto not known to be aluminium-accumulating, are: Meriana*, Mecranium*, Heterotrichum, Charianthus, Tetrazygia, Blakea, Henriettea*, Henrietella, Necrameum, Mouriria*, Coussarea, Declieuxia*, Chasalia*, Cœlospermum*, Borreria.

Those genera marked with an asterisk have given highly positive aluminium reactions in practically all of the species tested and thus might safely be regarded as wholly aluminium-accumulating under favourable conditions. To date, 173 new aluminium-accumulating plants have been discovered out of 417 species qualitatively tested in Trinidad, and possibly 3,000 more, if all the species of proved genera (including many untested blue-fruited species) are taken into account.

The qualitative test is, briefly: about one square inch of crushed leaf material, placed in a test-tube with about one c.c. of 'Aluminon' reagent, is heated for five minutes in a boiling water bath. A deep red colour indicated an aluminium accumulator with more than 1,000 p.p.m. in the dry material. The reagent[3], which is quite stable for many months, consists of 0·75 gm. 'Aluminon', 200 gm. ammonium acetate, 15 gm. gum acacia, 189 ml. concentrated hydrochloric acid, dissolved separately, mixed and made up to 1,500 ml. This buffered and stabilized reagent was also used in quantitative determinations of aluminium. In the accompanying table, data are presented to illustrate the range of aluminium concentration in some of the plants mentioned here.

	Aluminium, p.p.m. dry leaves	Where grown
Blue fruits		
Miconia nervosa (Sm.) Tr.	9,160	Trinidad
Symplocos cratægoides Ham.	6,560	England
Coccocypselum guianense (Aubl.) K. Sch.	5,810	Trinidad
,, ,, (fruit)	1,810	
Faramea axillaris Standl.	32,100	Peru
Cephælis tomentosa Willd.	9,950	Trinidad
Psychotria brachiata Sw.	15,400	Trinidad
Palicourea vestita Standl.	9,100	Costa Rica
Rudgea justicoides Standl.	36,800	Peru
Memecylon Arnottianum Wight	> 10,000	Ceylon
Blue fruits and blue flowers		
Faramea eurycarpa Donn. Smith	35,000	Costa Rica
F. rectinervia Standl.	16,000	Peru
Psychotria Herzogii S. Moore	22,600	Bolivia
Blue flowers		
Hydrangea macrophylla DC.	13,000	Trinidad
,, ,, (pink flowering)	60	England
Faramea anisocalyx P. and E.	36,900	Peru
F. insignis Standl.	40,000	Colombia
Palicourea amethystina (R. and P.) DC.	11,800	Peru
P. nigricans Krause	17,100	Peru
Memecylon polyanthemos Hook	> 10,000	W. Africa
Mean for 26 calcifuges of non-accumulating families[3]	206	England

The cell sap acidity range of aluminium plants was shown[3] to be *p*H 4·3–5·5, with the largest proportion of species at *p*H 4·3–4·6. Tests on 40 Trinidad species extended the range to *p*H 3·6 and the distribution was greatest at *p*H 3·6–4·0. Over these acidities the normal colours for delphinidin pigments are red but the delphinidin-aluminium lakes are blue. This was readily demonstrated by macerating petals or berries with a series of buffer solutions. The blue fruits of *Cephælis tomentosa* and *Psychotria brachiata* were still blue at *p*H 3·6 and changed to purple at *p*H 3·4. Normal delphinidin pigments in the pink hydrangea or the blue forget-me-not were red over this range, but on adding a drop of dilute aluminium sulphate solution they turned sky-blue.

During the search in the available floras[6–11] for blue-fruited plants it was found that some were also blue-flowering and that many other members of the same genera were blue-flowering although not blue-fruiting, and a few of the latter were even known to have flowers varying from blue to pink. These were just the plants that would be likely to fulfil the requirements for the hydrangea phenomenon. The blue-flowering aluminium plants disclosed are as follows: 2 *Cephælis*, 5 *Psychotria*, 16 *Memecylon*, 26 *Faramea* and 26 *Palicourea*. Variable flowers are those of: *Palicourea alpina*, *P. angustifolia*, *P. heterochroma*, *P. lasiantha*, *P. nigricans* and *P. pulchra*. Closest to *Hydrangea macrophylla* in showiness is *Faramea anisocalyx*, which has blue flowers and spectacular sky-blue bracts. These bracts have been noted by collectors in Peru as being sometimes pink. Whether this colour-variability is due to soil differences is not known; but it is a probability. Attempts will be made to obtain seeds of this attrac-

tive plant in order to grow it under conditions of high and low soil acidity.

The unique nature of hydrangea flowers is now questionable from the evidence submitted above; cultural tests will give the final answer. This investigation is being continued with further plant material, generously supplied by the Chicago Natural History Museum and the British Museum (N.H.).

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RELATIONS BETWEEN THE SOURCE OF NITROGEN AND ANTIBIOTIC FORMATION BY *ASPERGILLUS FUMIGATUS*, FRESENIUS

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MANY papers have been published on the antagonism of certain micro-organisms against acid-fast bacteria, particularly *M. tuberculosis*[1-13]. In this connexion the metabolic products of the various strains of the group *Aspergillus* are receiving considerable attention. Fumigatin[14], spinulosin[15], helvolic acid[16] and gliotoxin[17] are the four metabolic products of *A. fumigatus* which show considerable antibiotic activity. The present communication relates to a study of the formation of antibiotic activity and the source of nitrogen by *A. fumigatus*, Fresenius. The strain of this organism was obtained from the Imperial Institute of Agricultural Research, New Delhi, isolated by Mr. G. Smith of the London School of Tropical Medicine.

A. Inorganic and Organic Sources of Nitrogen

In the place of sodium nitrate of Czapek-Dox medium, inorganic and organic sources of nitrogen were used, so that the media contained the same amount of nitrogen as in Czapek-Dox medium (33 mgm. of nitrogen per 100 c.c.). To these modified media, sodium chloride was added, the sodium ion concentration being the same as in the Czapek-Dox medium.

Bacteriological test-tubes 15 cm. long and 1·7 cm. in diameter containing 5 c.c. of the medium were sterilized at 15 lb. pressure for half an hour and inoculated with a spore-suspension of the organism. The tubes were then placed in a slanting position, at an angle of about 20–30° to the horizontal, so as to furnish large surface for growth, and incubated at 28° C. (mean). Duplicate tubes from each group were removed at intervals of 24 hours and the antibiotic activity determined, according to Foster and Woodruff[18], using *B. subtilis* as the test organism. The reactions of the media were also recorded. The initial pH of the media in all cases before inoculation with spore-suspension was adjusted to pH 4·3, unless otherwise stated. The results are presented in Table 1.

TABLE 1

Source of nitrogen	pH	Growth characteristics	Antibiotic activity
1. Sodium nitrate	pH slowly rose, becoming alkaline on the fifteenth day	Growth was observed on the third day, as white surface mat, which was complete on the seventh day and had few spores.	Activity on the fifth day only (pH 5·8). Halo-diameter 12 mm.
2. Ammonium chloride	pH 3·4 on the second day after inoculation and did not change further.	Growth was observed on the second day. Surface mat full of blue spores was complete on the fifth day.	No activity.
3. Ammonium sulphate	do.	do.	do.
4. Ammonium nitrate	do.	do.	do.
5. Urea	do.	Growth was observed on the second day. Surface mat with spores being complete on the third day.	do.
6. Glycine	do.	do.	do.
7. Aspargine	do.	do.	do.

From these results it is clear that the Czapek-Dox medium favours the formation of the antibiotic, with simultaneous shift in the pH of the medium to the alkaline side. With the other sources of nitrogen, no antibiotic activity is detectable and the pH of the media becomes more acidic. Evidently these sources of nitrogen favour the formation of acids by the organism.

B. Complex Nitrogen Sources

We have utilized enzymic digest of groundnut cake, supplemented with minerals, and wheat bran as sources of nitrogen under this group.

(1) The preparation of the enzymic digest of groundnut cake is described by Rao and Venkataraman[19]. The ratio of the total nitrogen to the amino nitrogen (complex) in the digest is 4·75. The experimental procedure outlined in *A* was employed for growing the organism and testing the antibiotic activity of culture fluids. The results are summarized in Table 2.

The unsupplemented groundnut cake hydrolysate favours the formation of maximum antibiotic activity on the third day. With rise in the pH of the medium, the activity slowly decreases from the fourth day onwards. The addition of the constituents of the Czapek-Dox medium without sodium nitrate to the hydrolysate seems to have no significant influence on the antibiotic formation. However, the addition of 0·5 per cent sodium chloride or 2 per cent sodium acetate to the groundnut cake hydrolysate seems to exert a stabilizing influence on the antibiotic. A similar observation has been made by Cook *et al.*[20] on the stabilizing influence of sodium chloride in the production of penicillin using fractions obtained from the aqueous extracts of pea.

(2) 5 gm. of wheat bran contained in 250 c.c. conical flasks were moistened with 10 c.c. of water and mixed well. The flasks were plugged and auto-

TABLE 2

Composition of media	1 Groundnut cake hydrolysate alone. Total solids adjusted to 2 per cent	2 Groundnut cake hydrolysate (total solids 2%) + Czapek-Dox minerals and glucose, but no sodium nitrate	3 Groundnut cake hydrolysate (total solids 2%)+0·5% sodium chloride	4 Groundnut cake hydrolysate (total solids 2%) + 2% sodium acetate
Initial *p*H	4·3	4·3	4·3	7·2
First day after inoculation				
(a)	+	−	−	+
(b)	4·4	4·4	4·4	7·2
(c)	Nil	Nil	Nil	Nil
Second day after inoculation				
(a)	+	+	+	
(b)	5·1	4·7	5·3	
(c)	Nil	Nil	Nil	
Third day after inoculation				
(a)	+	++	+	+
(b)	7·2	5·3	7·2	7·3
(c)	14·5	Nil	14·5	12·0
Fourth day after inoculation				
(a)	++	++	+	+
(b)	7·5	7·2	7·6	7·4
(c)	11·5	14·5	13·5	16·0
Fifth day after inoculation				
(a)	++	++	+	++
(b)	7·7	7·5	7·7	7·6
(c)	11·0	11·5	13·5	16·0
Sixth day after inoculation				
(a)	++	++	++	++
(b)	8·0	7·7	8·0	7·8
(c)	11·0	11·0	11·5	11·0
Seventh day after inoculation				
(a)	++	++	++	++
(b)	8·1	8·0	8·2	8·0
(c)	10·5	11·0	11·0	10·5
Eighth day after inoculation				
(a)	++	++	++	
(b)	8·1	8·1	8·2	
(c)	9·5	9·5	9·5	

(*a*) Growth characteristics: − indicates no growth, + indicates growth without spores, ++ indicates growth with spores; (*b*) *p*H of the culture filtrate; (*c*) Activity (mean halo-diameters in mm.).

claved at 15 lb. pressure for half an hour. The sterile moist wheat bran was then inoculated with a spore-suspension of the organism and incubated at 28° C. At intervals of 24 hours one flask was removed, 10 c.c. of sterile water was added, mixed well and contents pressed through cloth. The antibiotic activity of the pressed liquid was determined. From the results presented in Table 3 it is obvious that the maximum antibiotic activity is reached on the fifth day.

TABLE 3

Days after inoculation	Growth characteristics	Antibiotic activity (mean halo-diameter in mm.)
1	No growth	Nil
2	White surface growth, no spores	Diffused halo
3	Thick mat, blue spores	11·0 mm.
4	do.	11·0
5	do.	15·0
6	do.	13·0
7	do.	12·0
8	do.	11·0
9	do.	10·5

From the set of experiments in Table 3 we may conclude that *A. fumigatus*, Fresenius seems to utilize preferentially complex sources of nitrogen for the production of antibiotic. Experiments are in progress for the concentration and isolation of the metabolic products of the organism when grown on groundnut cake hydrolysate in presence of sodium ions. Results of these and other related investigations will be published elsewhere.

Our thanks are due to Prof. V. Subrahmanyan and Drs. N. N. De and K. P. Menon for their kind interest in the work. We acknowledge the generous support of the Council of Scientific and Industrial Research, New Delhi.

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PENICILLIN TREATMENT OF SYPHILIS

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A MEETING of the investigators into penicillin treatment of the U.S. National Research Council was held in Washington during February 7–8 under the auspices of the U.S. Public Health Service. The meeting was attended by more than two hundred medical men, and Dr. J. E. Moore, presiding, opened the discussion. He stated that the United States Public Health Service had taken on the organised study of syphilis in January 1946. The present data are up to August 1945, and cover some twenty-six treatment schedules with intramuscular penicillin, varying from 0·06 to 2·4 million units with time ranges of $3\frac{3}{4}$, $7\frac{1}{2}$ and 15 days, and sometimes combined with other agents. Penicillin in oil beeswax has also been studied. More than 10,400 cases have been treated by one of the official schedules. New research schedules were announced.

Dr. N. R. Ingraham (Philadelphia) described the results of treating 79 pregnant women suffering from early symptomatic syphilis and 35 suffering from latent syphilis. From both series there were only three abortions and one child found suffering from congenital syphilis. A success-rate of syphilis prevention of more than 97 per cent was claimed to be unequalled by any other mode of treatment.

Dr. Platou (Tulane University) described 191 cases of congenital syphilis treated at a mean age of 164 days. He concluded that so far sodium penicillin

is the best agent yet employed in the treatment of congenital syphilis.

Dr. Rosahn gave the cumulative observations on early syphilis of the participating clinics as analysed by the Central Statistical Unit of the Johns Hopkins University. He showed by means of charts that: (1) The cumulative percentage of failures varied inversely with the total dosage. (2) The cumulative failure-rate at eleven months with 300,000 units of penicillin alone was twice as great as when combined with 320 mgm. 'Mapharsen'. (3) No sizeable differences were noted if the injections were spaced 3 or 6 hours apart or whether the treatment was continued for 3¾ or 7½ days. (4) For long durations of the disease before treatment the failure-rate was higher than for a short time. (5) No difference was noted as between coloured and white races. The female rate was slightly higher than the male. (6) Patients retreated for clinical failure showed a higher cumulative rate failing again than a comparable group of previously untreated secondary syphilis. (7) A comparison of different clinics handling the same schedules showed marked differences in the percentages becoming sero-negative even when laboratory techniques were apparently the same.

Lieut.-Col. T. H. Sternberg gave details of 1,107 Army patients treated with 2·4 million units over 7½ days. Only in 9·5 per cent of cases was the treatment considered to be unsatisfactory, and the speaker believed this was a good treatment. Dr. Evan Thomas (New York), on the other hand, had treated 1,119 patients with 1·2 million units of penicillin given three-hourly over 7½ days plus 0·04 gm. 'Mapharsen' daily for 8 days. Of 611 patients followed there was a failure-rate of 12 per cent at 6 months. With 1·2 million units of penicillin only there was a failure-rate of 17·6 per cent of 556 followed for the same time. Dr. Schoch (Dallas) had treated 291 cases with 1·2 million units of penicillin over 7½ days plus 1 gm. of bismuth subsalicylate in oil. The failure-rate at 160 days was 6 per cent as compared with 10 per cent on the same dose of penicillin alone. Dr. G. X. Schwemlein (Chicago) described 108 patients treated with 1·2 million units of penicillin over 7½ days plus a three-hour fever session of 106° F. (rectal) administered by hypertherm on the second, fourth and sixth days. The patients were observed for 154–353 days and there has been a 14·7 per cent failure-rate to date. A further 202 patients were given a two-day treatment. These patients have been observed 153–361 days and 19·3 per cent of failures have occurred to date.

Capt. J. M. Romansky described his work on penicillin in oil beeswax. 300,000 units per c.c. peanut oil with 4·8 per cent by weight of beeswax is recommended as the optimum strength. Calcium penicillin of 1,000 units per mgm. is essential. Calcium penicillin in oil beeswax maintains potency over a year at room temperatures, but the sodium salt not only produces erratic blood levels but also begins to deteriorate after 3–4 months.

Dr. R. C. Arnold showed results of increasing doses of penicillin given over decreasing periods of time in rabbit syphilis. He concluded that rabbit syphilis could be cured in 12 hours or less and that additional studies should be undertaken with the object of intensifying and shortening the treatment of syphilis patients. Dr. H. Eagle took the opposite view and considered the intensification of the dose a waste of penicillin, as it would be 'thrown away', and considered a second dose after an interval of far more value. He went on to describe his experiments, showing that the effects of 'Mapharsen' and penicillin in rabbit syphilis were synergistic. He stated that with the addition of subcurative doses of 'Mapharsen', the amount of penicillin required to cure rabbit syphilis is reduced to a fraction of that required when penicillin is used alone. He stated, too, that, as arsenic combines with spirochætes, when given over a short period of time the arsenic which is concentrated many times within the spirochæte was equivalent to penicillin given over a long time, as the latter is only effective as long as it remains in the surrounding fluid. Dr. C. M. Carpenter, working on penicillin and fever in rabbit syphilis, found much better results with fever combined with multiple rather than with single injections and considered that the effects of penicillin and fever were additive.

Dr. J. H. Stokes (Philadelphia) described 191 cases of late syphilis observed for more than 120 days and treated with penicillin on two dosage ranges of 1·2–4·8 million units and 4·8–10 million units in from one to four courses. He concluded that penicillin sodium in saline solution is effective to a greater or lesser degree in all aspects of neurosyphilis studied, that its most striking effects are seen in the spinal fluid, and that this good effect extends over weeks and months, though the maximum results are usually seen in the first 120 days. He found that there was no apparent concomitance between the response in the spinal fluid and that in the blood.

Against these and other encouraging reports, Dr. R. R. Kierland (Mayo Clinic), describing 49 cases receiving up to 16 million units, and in some instances fever in addition, concluded that in neurosyphilis, penicillin does not achieve the results that it does in the other forms of the disease.

Within a week of the Washington meeting further important data came to light. Two laboratories working on the various fractions of penicillin in rabbit syphilis found that penicillin *K* was markedly less effective than penicillin *G*. As commercial penicillins recently have contained much more penicillin *K* than was formerly the case, the statistics of the Johns Hopkins Hospital were re-analysed as regards the time factor. It was found that cases treated prior to May 1944 fared much better than those treated after that date. It was concluded that, while this was probably due to the effect of the increasing amounts of penicillin *K* present in the commercial penicillins, the question of the removal of impurities must also be considered.

VISITORS' RESEARCH STATIONS IN THE TROPICS

In a report to the Pacific Science Conference (Washington, D.C., June 1946), Dr. Frans Verdoorn, editor of *Chronica Botanica*, has directed attention to the desirability of suitable provision being made for biologists who wish to study and make collections in different tropical regions. As an indication of the kind of facilities that might be offered he refers briefly to the International Zoological Station at Naples created by Dohrn. This large and well-equipped station was established, in an area rich in fauna and flora, to afford laboratory, collecting, museum and library facilities to visiting biologists from all parts of the world. The financing of the

Station is on an international basis. "No words," says Verdoorn, "can describe the inspiration, as well as the scientific results, for which the Naples Station may be given credit."

To afford comparable facilities in suitable areas in the tropics Verdoorn makes a plea for the establishment of what he describes as "Visitors' Research Stations". Many will sympathize with him in this aim. The present method whereby visitors make use of facilities already existing, such as the laboratories of botanic gardens, departments of agriculture, etc., has its disadvantages. It is true that, by his personal influence, Treub as director of the Buitenzorg Botanic Gardens in Java and later at Tjibotas created what was in fact an informal, international, biological station, and men of science were attracted to it from all parts of the world. He organised a small, well-equipped laboratory for visitors, and provided adequate but inexpensive living facilities. Verdoorn would, however, prefer to have such facilities on a different footing. Briefly, his model would operate along the following lines. The Visitors' Station would not be informal and dependent; but a more or less independent unit, associated with the existing agricultural or biological institutions. It would consist of a large modern laboratory, equipped for simple research in all branches of biology, physiology, chemistry, etc. It would be provided with a small library of general reference works, for example, literature on local floras, maps, etc., periodicals being consulted in the large libraries of the adjacent institutions. There would be a small 'social building' with a theatre for films, lectures, etc., and, not least important, a modern dormitory and restaurant and a medical annexe, each with its permanent staff.

The laboratory would have a small permanent staff, consisting of a director—"an organiser with international experience and idealism, willing to sacrifice a good part of his own opportunities for research in order to aid and assist others"—and a small number of resident specialists well versed in the local flora, fauna, etc., and therefore capable of directing visitors to the materials which they might require in their work.

The aims of such a station would be, broadly speaking, to promote scientific research in the tropics and to develop interest in biological science at all levels of specialization against the tropical background. As to why these things should be done, Verdoorn gives several reasons. Access by biologists to tropical materials, and personal experience of tropical conditions, are of themselves of great importance. But Verdoorn gives another reason of great practical importance at the present time, and possibly for decades to come. "Except in times of worldwide economic depression, it is difficult to get even fair numbers of first-class scientists to do research and experiment station work for the majority of the tropical countries. It has always been so and will remain so in most countries, whatever progress is made in travel, medicine, refrigeration, and local education. For the development and reconstruction of the larger tropical areas a great number of scientists are needed. They must be good scientists, not men who come merely because they cannot succeed elsewhere." This is absolutely correct and sound. No one with recent experience of agriculture, and biological science generally, in the tropics, whether of the Old World or of the New, will challenge this statement. There have been too few good biologists in the tropics in the past: the personnel situation is still more aggravated at the present time while the problems have gained in magnitude.

On the location of the visitors' research stations, Verdoorn is explicit: they will be developed in proximity to existing institutions, for example, at Buitenzorg, Calcutta, Peradeniya, Manila, etc. There should, of course, be a close and sympathetic understanding between the visitors' station and the existing institutions.

Lastly, while the general argument has been developed in terms of the biological sciences, the field of work could be extended to all scientific subjects where field-work is important. The method of procedure for the development and financing of such stations has yet to be worked out. Whatever the system eventually adopted may be, biologists have reason to be grateful to Dr. Verdoorn for his timely emphasis of the fact that facilities for tropical study should be provided on an international basis as soon as possible in the general interest.

MEASUREMENT OF VISCOSITY

A MEETING of the British Rheologists' Club was held on June 15 at the National Physical Laboratory, Teddington, by courtesy of the director, when Dr. Guy Barr spoke on recent developments in viscometry, including the calibration and design of standard viscometers.

After giving a survey of early ideas on viscosity leading to Maxwell's definition of dynamic viscosity, Dr. Barr stressed the importance of kinematic viscosity, which came into importance later because of its application in hydraulics and especially in aerodynamics. Until 1913, no name was attached to the unit of viscosity; Deeley and Parr then suggested the word 'poise' (from Poiseuille) for η, the unit of dynamic viscosity; and later, in 1928, Jakob proposed the word 'stoke' (from Stokes) for ν, the unit of kinematic viscosity; $\nu = \eta/\sigma$ where σ is the density of the liquid. These names and their derivations, namely, centipoise (cp.) and centistoke, have been universally adopted. The poise has the dimensions $ML^{-1}T^{-1}$, and is correctly expressed as grams/cm./sec., whereas the stoke has the dimensions L^2T^{-1}, that of a diffusion of momentum.

Dr. Barr pointed out that the Ostwald, and U-type viscometers in general, are subject to small errors if not placed strictly vertical, and modifications of their design to minimize the error have been made by Gruneisen, Fenske, Ubbelohde, and others; these modifications are much in use with petroleum products. Fenske places the reservoirs one above the other and Ubbelohde in his suspended level viscometer does not require any particular quantity of liquid. Small discrepancies in results obtained with carefully calibrated standard viscometers by observers in different laboratories (joint meeting of Institute of Petroleum and British Rheologists' Club, *J. Inst. Pet.*, **31**, 260; 1945) cannot be attributed to gravity variations, observational errors, or lack of temperature control, etc., but appear to be due to differences of surface tension in the standard liquids used for calibration. With water and sugar solutions, the surface tensions and contact angles are considerably higher than with the petroleum oil standard calibrating liquids. Dr. Barr described experiments illustrating the effect of surface tension on the flow

of liquids in viscometers, and exhibited viscometers designed to eliminate the surface tension difficulty.

On the subject of the measurement of viscosity of non-Newtonian liquids, Dr. K. Weissenberg mentioned the method of making the liquid system vibrate and observing the wave motion. The meeting discussed the use of the falling sphere method; Dr. E. Mardles pointed out that the rate of fall of a sphere through paints and greases varies considerably with depth, and often the sphere remains suspended, a finding confirmed by Dr. Barr, who with an unusual sample of tar and using X-ray photography found that the ball remained practically suspended before reaching the bottom. Dr. Mardles has obtained more promising results by using a thin plate drawn through the system, the rate of movement being nearly constant through the bulk. By varying the weight attached to the fine thread over a light pulley pulling the plate, it is possible to determine the yield value (see *Nature*, August 10, p. 199).

Those present visited departments where investigations of a rheological character were in progress; these included the silting of harbours, the slow creep of metals, the ventilation of buildings, plastics, use of strain gauges, etc.

UTILIZATION OF AFRICAN FOREST WOODS

WAR production forms the main theme of the annual reports of some of the African forest services—the demands for timber and wild rubber production, the latter due to the disappearance of the Malayan supplies. In the report for 1943 from Nigeria (Govt. Printers, Lagos, 1944) it is stated that military demands for timber revived, while the projected relaying of the railway line between Jebba and Minna required over a period of three years 300,000 sleepers. It was hoped to supply a high proportion of these from the Kurmis of the northern provinces, from *Khaya senegalensis* and *grandifoliola*. Trouble was experienced from warping and cracking due to an exceptionally severe harmattan; an exacting specification impossible for pit-sawyers to fulfil and other difficulties were experienced. These resulted in a high percentage of rejects, so the work of supplying is to be transferred to the southern provinces, although this involves long haulages by rail. Besides this railway contract, of which a portion was cut, 333,358 cu. ft. were produced for military use; 1,455,730 cu. ft. for local consumption; 40,924 cu. ft. from the mines, and 2,038,592 cu. ft. by logs and timber cut for export. This latter went to the United Kingdom, United States, South Africa, other parts of West Africa and French West Africa. One notable result of this increased war demand for timber, especially sawn timber required by the military, is the substantial and growing local demand by the African for this last type of material, which should, in the future, result in far better housing conditions for the population.

In the report for 1943–44 from the Gold Coast (Govt. Printing Department, Accra, 1944) timber and rubber production appear to have proved the chief preoccupations of the Department. Apart from the pit-sawn timber used locally, the pit-sawn timber supplies handled by the Department through its numerous subcontractors totalled 1,060,000 cu. ft. This was supplied to the British Services, United States Army, Government Departments, etc. 133,000 pit-sawn sleepers required for an extension of the Gold Coast Railway and demanded at short notice were included in the above. One outcome of the military demand was the making of furniture in the Colony, a woodworkers' company having been started in Accra. Here again this may lead to the adoption of better types of furniture in the houses of the Africans in the future. In the Gold Coast, as in India and other parts of the Empire, the demand for tool handles was met by local production, and cutlass handles, and handles for felling axes, pick axes, shovels, hoes, rakes and all kinds of hammers were prepared from local woods; as also shingles for roofing.

The annual report for 1944 for Uganda (Government Printing Department, Uganda, 1945) says that the demand for timber for operational use by the military became more pressing and everything possible was done to increase output by opening up new areas and arranging for the circulation and extension of sawmills. The nine firms working exclusive licences operated twelve mills and produced 32,873 tons of 50 cu. ft. of sawn timber each, plus 746 tons of export logs. Eleven other firms with twelve mills turned out 7,541 tons of sawn timber, while pit-sawyers produced 3,835 tons. This timber came from the crown lands, crown forests and private forest (about one sixth only). 79 per cent of the total went to the military, 8½ per cent to the civil governments, and the balance to the public. Exports were 749 tons of logs and 39,148 tons of sawn timber, including 126,395 sleepers. The report gives interesting information on the wild rubber collection, which has absorbed a proportion of the staff of all the Departments. "The Wild Rubber section collected 25·75 tons of dry *Funtumia* rubber in Bunyoro and private enterprise 8·04 tons in the Mabira Forest, while in Buganda the Department bought 3·13 tons of vine rubber and private enterprise 2·47 tons. All possible *Funtumia* trees have been severely tapped twice in two years and are exhausted, so tapping was stopped at the end of the year."

It is to be hoped that all the Departments, now that war-time demands have ceased, will undertake a careful inventory of their exploited forests, so as to bring to an end any further overfelling where such has occurred.

ASSISTANT LECTURER OF LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, University College, Hull (August 31).

CIVIL ENGINEER (MAINTENANCE) in the Department of the Civil Engineer—The Chief Staff and Welfare Officer (reference E.R./E 250), London Passenger Transport Board, 55 Broadway, London, S.W.1 (August 31).

DIRECTOR OF THE DEPARTMENT OF SCIENTIFIC AND TECHNICAL LIAISON OF THE INTERNATIONAL WOOL SECRETARIAT—The Secretary, International Wool Secretariat, Grand Buildings, Trafalgar Square, London, W.C.2 (August 31).

ASSISTANT LECTURER AND DEMONSTRATOR IN BOTANY, with special preference for Plant Pathology or Genetics—The Registrar, University College, Cathays Park, Cardiff (August 31).

LECTURER (man or woman) IN PHARMACEUTICAL SUBJECTS at the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth (August 31).

ASSISTANT LECTURERS (2) IN GEOLOGY—The Registrar, The University, Manchester 13 (August 31).

ASSISTANT LECTURER IN APPLIED CHEMISTRY—The Registrar, College of Technology, Manchester 1 (August 31).

LECTURER IN PHYSIOLOGY—The Registrar, Technical College, Sunderland, Co. Durham (August 31).

RESEARCH ASSISTANTS (2), one for work in LAND UTILIZATION and one for work in AGRICULTURAL STATISTICS—The Professor of Agricultural Economics, University of Reading, 7 Redlands Road, Reading (August 31).

ENGINEERING INSPECTORS (12)—The Establishment Officer, Ministry of Health, Whitehall, London, S.W.1 (from the United Kingdom, August 31; from Overseas, September 28).

LECTURER IN CHEMISTRY, a LECTURER IN THE NATURAL SCIENCE DEPARTMENT, a LECTURER IN CIVIL ENGINEERING, a LECTURER IN NATURAL SCIENCE DEPARTMENT with Honours Degree in Botany, a LECTURER IN CHEMISTRY, a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Principal, Derby Technical College, Normanton Road, Derby (September 1).

PRINCIPAL RESEARCH OFFICER or SENIOR OFFICER (PHYSICIST) in the Atomic Research Laboratory, University of Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting Appointment No. 919 (September 2).

OFFICER-IN-CHARGE, CONCRETE RESEARCH, Building Materials Research Section, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting Appointment No. 802 (September 2).

LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, The University, Aberdeen (September 6).

JUNIOR LECTURER or LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 7).

CURATOR OF THE ROYAL BOTANIC GARDENS, TRINIDAD—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting G.286 (September 7).

TEACHER OF SCIENTIFIC INSTRUMENT CONSTRUCTION AND DESIGN at the South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, London, S.E.1 (September 14).

HEAD OF THE DAIRY HUSBANDRY DEPARTMENT—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (September 15).

SENIOR LECTURER (ungraded) IN THE DEPARTMENT OF PATHOLOGY—The Registrar, The University, Liverpool (September 16).

LECTURER IN ELECTRICAL ENGINEERING—The Secretary, King's College, Strand, London, W.C.2 (September 16).

PROFESSOR OF ENGINEERING—The Registrar, University College, Singleton Park, Swansea (September 21).

LECTURER (ungraded) IN THE DEPARTMENT OF PATHOLOGY—The Registrar, The University, Liverpool (September 23).

METEOROLOGICAL OFFICERS IN THE COLONIAL SERVICE :—(a) Officers (4), Malayan Meteorological Service; (b) Assistant Director, Observatory, Mauritius; (c) Professional Assistants (2), Royal Observatory, Hong Kong—The Director of Recruitment, 15 Victoria Street, London, S.W.1 (October 5).

LECTURER and an ASSISTANT LECTURER IN CIVIL OR MECHANICAL ENGINEERING—The Registrar, University College, Nottingham.

ASSISTANT IN EACH OF THE DEPARTMENTS OF LOGIC AND MORAL PHILOSOPHY—The Secretary, The University, Aberdeen.

GRADUATE IN CHEMISTRY OR PHYSICS for the Intelligence Division and Library—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

SENIOR LABORATORY ASSISTANT to take charge of the chemical stores, maintenance of the chemistry and physics laboratories and repair of glass apparatus—The Principal, Medway Technical College, Gillingham, Kent.

LECTURER IN GEOLOGY—The Principal, Kingston Technical College, Kingston-upon-Thames, Surrey.

ASSISTANT TECHNICIAN IN PHYSICS DEPARTMENT—The Secretary, Mount Vernon Hospital, Northwood, Middlesex.

RESEARCH PHYSICIST for work on vacuum spectroscopy—Prof. Ditchburn, c/o Registrar, The University, Reading.

LABORATORY ASSISTANT (Grade I) FOR THE PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

LECTURER IN PHYSICAL AND ENGINEERING METALLURGY, preferably with experience in Mechanical Treatment and Welding—The Secretary, Imperial College of Science, South Kensington, London, S.W.7.

HONOURS GRADUATE (male) with previous research experience in chemistry or physics for fundamental investigations in the properties of rubber-like polymers—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

TECHNICAL ASSISTANT IN THE DEPARTMENT OF PLANT PHYSIOLOGY—The Registrar, Queen Mary College, Mile End Road, London, E.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Science in Post-Primary Education, with reference to the Scientific Education in Schools of Pupils of 11–18, and its relation to their Subsequent Training in Universities and Colleges. Second Part of the Report of a Sub-Committee of the Association of Women Science Teachers. Pp. vi+57. (London: John Murray, 1946.) 2*s*. [53

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MACHINERY OF GOVERNMENT

IN addressing the Joint Research Council in Manchester last December, Sir John Anderson dissociated himself from the proposal to establish a Minister or Ministry of Science, and in his address at the Federation of British Industries Conference on Industry and Research last March, he indicated more specifically why he regarded that as a mistaken conception. Most departments of State, he pointed out, in some part of their work have recourse to science, and should be free to develop their own organisation. There are also scientific problems beyond the scope of departmental responsibilities in which the Government should take a hand, and for that purpose some one Minister should be designated and equipped with the necessary staff, which need not be large but should be of the highest quality. The obvious Minister for this purpose, Sir John suggested, is the Lord President of the Council, who is already responsible for the three main extra-departmental scientific organisations.

These ideas Sir John Anderson has since developed more fully in his Romanes Lecture at Oxford on May 14, "The Machinery of Government". In this lecture*, Sir John begins with some discussion of our system of Cabinet government and the way in which developing responsibilities of the central government have led to a steady growth in the size of the Cabinet and in the machinery of the central government becoming unwieldy. Rejecting the idea of supervising ministers co-ordinating the work of departments, he advocates the development of a series of Cabinet committees, the functions of which he proceeds to illustrate more particularly by reference to the fields of economics and of science.

It is somewhat surprising to find that Sir John, in discussing the changes which took place during the First World War and afterwards, and which Lord Hankey discussed more particularly in the Lees Knowles Lectures "Government Control in War", makes no reference to the Haldane Report, though that is presumably what he had in mind in rejecting the idea of a supervising minister as likely to break down in practice, and as inconsistent with the parliamentary responsibilities of departmental ministers and with departmental control. Authority over departments, he rightly says, must be undivided and unquestionable, and a supervising minister would mean, in practice, a supervising staff with endless possibilities of friction and clash.

What the Haldane Report recommended, however, was, not placing responsible ministers under a super-minister, but the consolidation or grouping of departments into a small number of super-ministries with one responsible minister for each. The obvious danger here is not friction, as Sir John suggests, but that of creating a bottleneck at the top, which might outweigh the advantage of the effective co-ordination of the work of ministers and departments handling different aspects of the same subject, and the lighter

* The Machinery of Government. By the Right Hon. Sir John Anderson. (The Romanes Lecture delivered in the Sheldonian Theatre, May 14, 1946.) Pp. 32. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 2s. net.

burden on the Prime Minister and the central organ of government thereby secured. The great merit of the alternative system of standing Cabinet committees which Sir John suggests is its flexibility. While the number and scope of the committees might vary from time to time to suit the actual situation, he visualizes some six committees which in effect would be subsidiary cabinets, covering, for example, defence, economic relations, external affairs, social services, with two others reviewing all proposals for legislation and questions of national economic development, respectively.

The chairman of each committee, Sir John suggests, might be either a non-departmental minister or a departmental minister with a dominant interest in the matters comprised within the particular group, but it should be clear that the chairman of such a committee would have no supervisory powers. Further, as a consequence, only the more important and difficult matters would be remitted to the full Cabinet; and in addition to reducing the Cabinet burden in this way, the necessity for a Cabinet of unwieldy size would be avoided. Such a system, however, requires for its successful functioning two conditions: the doctrine of the collective responsibility of the Cabinet as a whole must be fully maintained; and, secondly, the Cabinet committees must have available the services of a highly competent central staff.

The most important part of Sir John Anderson's lecture is that in which he deals more specifically with the functions of the Cabinet secretariat as an instrument for providing the Cabinet with the expert research and intelligence service which is an indispensable element in government to-day. Sir John may have done something less than justice to the proposals of the Haldane Committee, but what he says about the necessity of providing each department, within its own organisation, with the expert advice required for the efficient discharge of its day-to-day business, and also of providing the central government as a whole with more authoritative guidance in technical matters than any individual department could provide, is endorsed by every recent study of this subject, including the reports of the Select Committee on National Expenditure and two P.E.P. broadsheets. He is primarily concerned, however, to avoid in this connexion infringement of the principle of ministerial doctrine by even the appearance of setting up any independent source of authority, such as is implied by conceptions like an economic general staff or a scientific general staff.

Sir John Anderson points out that the functions of the recently created Economic Section of the Cabinet secretariat were settled after a careful review of the experience of the past. There has been, he said, a substantial measure of agreement that the main contribution to be made by economists to the work of the Government should continue to be made in the departments themselves. The functions of the Central Economic Section are conceived as the reception of all economic intelligence collected by various government agencies, covering by its own researches any gaps in that intelligence; making or procuring specific studies in spheres not covered by any one department; appraising economic intelligence, and presenting co-ordinated and objective pictures of the economic situation as a whole and the economic aspects of projected government policies. It should also be open to the Section to commission, where appropriate, special studies from universities or other institutions. Economic advice would be provided to particular departments, as well as to the Cabinet or Cabinet committees, on departmental matters on broader lines than are possible for the departments themselves; and in working closely with the departments, it is considered that the Section would facilitate contacts with, and exchange of views among, all economists in the Government service.

Similarly, Sir John conceives of the functions of a Central Statistical Office, organised as part of the Cabinet secretariat, as producing and maintaining a body of statistical information general in character, and presented in a form which would be regarded as authoritative by all departments, and with which the more detailed statistics provided by the departments themselves would comply. The same general model is advocated for scientific services. While the idea of a joint scientific staff on the lines of the Joint Planning Staff is rejected, Sir John hopes that a section of the Cabinet secretariat will be organised to assist the Lord President of the Council as the minister responsible for the general aspects of scientific investigation, and that thereby provision will be made, without prejudice to the work of departmental scientific staffs, for enlisting scientific advice on the highest level for the guidance of ministers.

Sir John Anderson did not pursue this matter further on the ground that the whole subject is at present under the consideration of a Government committee, though whether this is the Cabinet Committee on the Machinery of Government which was set up under the Coalition Government is not clear. At least it is to be hoped that the report and findings of any such committee will be published in full, for as Sir Ernest Barker has emphasized, this general problem of relating the expert's knowledge to the function of government is a key difficulty in democratic government. No more fruitful subject for research and study could well be conceived, for example, either for the British Institute of Management or the Administrative Staff College, both of which include research among their aims and functions.

That is well brought out in the final part of Sir John Anderson's lecture, when he passes to the consideration of the problems of administration which will arise in the phase of government ownership or control to which Great Britain is being increasingly committed by the present policy of nationalization. It is generally agreed that we here require organisation essentially different from the normal departmental organisation governed by Civil Service traditions. Whether we are being asked to move too rapidly in this matter is, as Sir John rightly indicates, a matter of personal opinion, but there is much to be said for his view that the problem is unlikely to be solved satisfactorily except by a process of experiment. Caution and a gradual approach as well as clear

thinking are required, and it is not unreasonable to suggest that only the gravest urgency from other points of view should lead to the tempo of the programme of nationalization being such as to give inadequate opportunity for such study, experiment and thought.

The special feature of the problem is that of devising organisation which can be relied upon under changing conditions to act with vigour, to exhibit in a high degree initiative and enterprise, to accept freely such risks as are taken every day by private enterprise, and to engage wherever necessary in competitive activity. In all this the public interest must be safeguarded to the satisfaction of Parliament as the ultimate authority, and having thus defined the problem, Sir John indicates certain guiding principles which must be served. For the constitution of the responsible authority, some form of council, committee or board will usually be indicated, and he strongly advocates a part-time rather than a whole-time basis as the most likely way to find people with the necessary breadth of experience, freshness of outlook and a reasonable measure of independence. While due regard should be had to the inclusion of different types of experience, representation of interests as such should be avoided. What may be termed the 'consumers' interest' should be left to the care of ministers and Parliament, and it is to the vigilance of Parliament and an alert public opinion that we must look to avoid undue political influence in the appointment of personnel.

As regards the relations of ministers and Parliament to this type of organisation, Parliament, as the ultimate authority, must have adequate opportunity for inquiry, for debate, and for passing judgment. Sir John suggests that the extent of ministerial control should be defined as clearly as possible in the instrument constituting the authority; but while he recognizes that within the field so defined the minister would be liable to be questioned in Parliament in the usual way, he does not really face the initial issue of the bearing of the Parliamentary question on the problem of ensuring initiative and enterprise. That may well be one of the matters in which much experience has yet to be gained before Parliament can be convinced that a satisfactory technique has been evolved.

What needs to be remembered, moreover, is that the problem is something more than one of devising machinery which serves the principles of departmental and collective responsibility. In a real sense, as Dr. J. T. MacCurdy and Dr. K. E. Barlow have pointed out, it is a complex biological problem, especially on the intelligence side. It is this biological aspect and the consequent need to give time for the evolution of the appropriate intelligence system which is probably one of the strongest reasons for 'hastening slowly' in matters involving a drastic change of policy. Sir John Anderson's lecture should stimulate further thought on a problem which has its bearing on almost every aspect of national life. On the more mechanical side of organisation with which he is chiefly concerned, he gives as clear warning as Sir Ernest Barker of the need for experiment, for a scientific approach and for critical and impartial examination of the alternatives. That can only be possible if time is allowed; and this plea for caution and for time for the accumulation and examination of experience is reinforced by all those biological and sociological considerations which Dr. MacCurdy and Dr. Barlow have emphasized in their writings. Disregard of these factors constitutes in reality one of the gravest threats to the stability and indeed existence of civilization.

THE UNDERGRADUATE'S FIRST YEAR

First Year at the University

A Freshman's Guide. By Bruce Truscot. Pp. 111. (London: Faber and Faber Ltd., 1946.) 4*s*. 6*d*. net.

THIS book is not ephemeral: it is in the perennial class. It will appeal to many in every generation of students and should be included in every 'sixth form' library. It puts first things last, but perhaps that is no disadvantage, for the less important matters dealt with in the earlier chapters are of primary concern to the university student in the 'professional' sense and will have for him the most immediate appeal. The fact that the advice given about them is sound and acceptable will give weight to that offered later on more fundamental aspects of life. To each individual reader, especially to those who are older and look back across the years, different portions of the book will appeal according to his experience, his limitations and his tastes. The appeal for "unobtrusive courtesy founded on a sense of mutual obligation" is perhaps the book's most valuable phrase, and might be directed as much, in these distracting days, to the more senior half of university society. The essay on concentration has the same universal appeal, but, to us seniors, with more than a suspicion of regret for opportunities missed. So many things that matter in university administration are not tied to an obvious time limit and are thus in danger of neglect.

The stressing of the importance of the 'society' for the amateur in all branches of university study is one of the author's more constructive contributions. This is one of the thoughts it is particularly to be hoped will be translated into action by undergraduates of the future who are readers of the book. There are few things more necessary for the full development of undergraduate society and few things more difficult to bring about. Such a development must come from students themselves, and the student of to-day is more obsessed with the professional or specialist aspect of his studies than his predecessors were in more leisurely days.

The only concept with which I take issue is not essential to the purpose of the book. It needs comment, however, because it is placed in the forefront of the argument. In my view, teaching *is* an essential function of the university to-day. It is foolish to contend that, because of the origin of universities, it is not. It necessarily became an *essential* function before the end of the working lives of the first generation of the Socii to whom the author refers in his opening chapter. If we do not recognize this develop-

ment, we fail to appreciate the essence of the university to-day. This view in no way conflicts with the idea that the pursuit of new knowledge was the original university objective and is to-day an equally essential element of university work. Indeed, the pursuit of new knowledge is not only an essential end in itself: participation in this search by all members of the teaching staff without exception is necessary for the maintenance of high quality in teaching. It is, however, neither necessary nor right to degrade the teaching either of undergraduates or graduates from its correct status as one primary and essential element of a university in order to establish this truth. If the view that teaching is only incidental to the real work of universities were generally held, university teaching would suffer; just as university research would suffer if research were held—as in places and at times it has been—to be a secondary component of university life. R. E. PRIESTLEY

APPLIED GYROSCOPY

The Gyroscope and its Applications
Edited by Dr. Martin Davidson. Section 1: General Theory, by Dr. M. Davidson; Section 2: Marine Applications, by G. C. Saul; Section 3: Aeronautical Applications, by J. A. Wells and A. P. Glenny. Pp. 256. (London: Hutchinson's Scientific and Technical Publications, 1946.) 21*s*. net.

THE applications of the gyroscope to marine and aeronautical problems during the Second World War have been so many that pre-war treatises have become out of date. This book is an endeavour to bring the subject up to date, with a minimum amount of mathematics. The subject is considered in three sections, each by a different author. The first section deals with the simple theory of the gyroscope, and with its main properties; appendixes are concerned, chiefly, with the errors of the gyroscopic compass. The second and third sections treat of the marine and aeronautical applications respectively, and each is self-complete. Since much of the material of these two sections is new and practical, they are of more interest than the first; they contain scarcely any mathematics; they are illustrated by excellent diagrams and photographs, and make exceedingly interesting, though very technical and at times difficult, reading.

The marine applications fall into three groups, the gyro compass, the gyro pilot and the gyro stabilizer. The idea of a gyro compass began when Sang in 1836 suggested, and Foucault in 1852 showed, that a gyroscope could demonstrate the rotation of the earth. The Anschütz gyro compass was patented in 1908, the Sperry in 1911 and the Brown in 1916. The latest forms of these three types, (*a*) the Sperry Mark XIV gyro compass, with one heavy rotor of mass 52 pounds spinning at 6,000 revolutions a minute, (*b*) the Brown gyro compass, with one rotor weighing $4\frac{1}{2}$ pounds and spinning at 14,000 revolutions a minute, and (*c*) the Anschütz gyro compass, originally having one rotor, later three rotors, and now having two rotors each of about $4\frac{3}{4}$ pounds spinning at 20,000 revolutions a minute, are described in full with excellent illustrations, and are compared and contrasted.

Successful relaying of the compass reading to repeater compasses led naturally to automatic steering. The gyro pilot is much more sensitive to slight changes in the direction of the ship's head than the human helmsman, and does not find the job monotonous, so that when properly designed it steers a straighter course, and saves time, fuel and man-hours. The actions of the Sperry gyro pilot and the Brown automatic helmsman are described, with photographs of the gear.

A chapter follows on the Sperry gyro ship-stabilizer, in which each gyro rotor weighs 100 tons and spins at 800 revolutions a minute, and in which the precessional action of these massive rotors damps out the roll. This is followed by a chapter on the Denny–Brown ship-stabilizer, in which a comparatively small gyro spinning at 6,000 revolutions a minute controls the means of damping out the roll; the stabilization is obtained by the use of fins projecting from the hull and oscillated in a similar manner to the ailerons of an aeroplane. The control gyro acts not merely when the ship is rolling, but even anticipates a roll. The fins are extended from, and retracted into, their housing in the hull by the same electrohydraulic machinery that angles the fins during stabilization.

Section 3 deals with aeronautical applications of the gyroscope. In many ways these contrast with marine applications. The speed of the aeroplane prevents the use of the gyro compass; nevertheless the gyro can be used, for local flights, as a direction indicator, much as the torpedo gyro controls the direction of the torpedo. Two examples are described, the Sperry directional gyro and the Brown static compass. When the directional gyro is monitored by a magnetic compass, the arrangement is called a gyromagnetic compass; examples given in detail are the R.A.F., the Sperry 'slave', and the Askania (German) gyromagnetic compasses. The Brown pitch-azimuth indicator, showing any divergence of an aircraft from a pre-set glide path, was produced for use in blind approach and landing. A chapter follows on rate-of-turn indicators; several types of these are detailed, including the Reid and Sigrist instrument, standard in the R.A.F.

The need for an accurate indication, to the pilot, of the vertical (or the horizontal) has led to the development of a large number of instruments, in which erection of a gyro, that is, adjustment of the gyro until its axis of spin is vertical, is carried out automatically by some device that applies the right couple, when required, to hurry the precession of the gyro about the vertical axis; such a gyro is called a gyro vertical. The Sperry artificial horizon provides a horizon bar on a dial, on which also is a miniature aircraft silhouette; the horizon bar is controlled in pitch and roll by a gyro vertical; thus the pilot can see at all times his flight attitude, even when flying in fog or heavy cloud. Erection of the gyro is carried out by air jets. The Gyrorector, of German design, though it does not use a gyro vertical, is a form of artificial horizon; in it the rotor is mounted with its axis horizontal and athwartships. In the O.M.I. artificial horizon, of Italian make, bank and pitch are indicated on a dial, as in the Sperry artificial horizon, by the relative movements of a horizon bar and a miniature aeroplane; erection is by the Gray method, in which when the rotor axis is not vertical; steel balls roll to positions where they exert the correct erecting couple. Paragraphs follow on the Sperry electrical artificial horizon, with automatic electrical erection, and on the Horn (German) artificial horizon, in which the erection is electrical, and in which a turn-indicator gyro, with axis fore-

and-aft, is also incorporated. A description is given of the Pioneer Bendix Fluxgate Gyro, an interesting instrument which is basically a magnetic compass maintained on an even keel by a gyro vertical. The compass, called a Fluxgate, is an inductive device responsive to the earth's horizontal magnetic field, and capable of providing remote magnetic compass readings on a repeater system ; the erector system of the gyro is of the Gray type.

The book closes with a chapter on automatic pilots, of which there have been many types since the first Sperry gyroscopic stabilizer was successfully tried out in 1909. The modern Sperry A3 gyropilot has a gyro vertical to control pitch and roll, and a directional gyro to detect yawing; the system is pneumatic-hydraulic. The Pollock Brown automatic pilot is entirely hydraulic; one gyro, with its axis fore-and-aft, is used for rudder and elevator control, while a second gyro controls the ailerons. The R.A.E. Mark I and Mark VIII automatic pilots are described and contrasted. The Mark I had a single gyro, and the arrangement was intended primarily as a stabilizing control in bombing; it had only rudder and elevator control. The latest Mark VIII has a single inclined gyro, and is monitored by a magnetic compass. A 1942 example of a German automatic pilot of the three-axis type is described. This elaborate instrument was all electric, and contained five gyros, respectively a directional gyro, a gyro vertical, and a gyro for each of the three axes. In the Minneapolis Honeywell automatic pilot, control is by a directional gyro with axis athwartships, and a gyro vertical with frictional erection. The V1 flying bomb of 1944 had three gyros; one gyro, monitored by a compass against random azimuth precession, controlled rudder and elevators; the other two were rate gyros, responsive one to rate of yaw and the other to rate of pitch.

There are many war-time applications of the gyroscope, for example, to gun sights and bomb sights, that cannot yet be published; the principles involved must be generally the same as those employed in the many devices described in this book, which, despite the unfortunate absence of an index, forms an excellent book of reference on modern applied gyroscopy.

ROBERT C. GRAY

INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING

The Chemical Process Industries

By Prof. R. Norris Shreve. (Chemical Engineering Series.) Pp. xiii + 957. (New York and London: McGraw-Hill Book Co., Inc., 1945.) 25*s*.

THERE has always been something intellectually unsatisfying about manuals, dictionaries and encyclopædias of industrial chemistry. To the works chemist, intimately acquainted with the details of a particular industry, they often appear superficial and elementary; to the student of chemistry they lack the imaginative appeal which is found in works on the pure sciences; to the chemical engineer, concerned primarily with the quantitative aspects of physical and chemical processes, they usually offer a qualitative and unbalanced *olla podrida* of engineering, chemistry and economics which is peculiarly irritating.

The disfavour into which such works have fallen can only be regarded as temporary, for there is a constant need for more information upon industrial procedures; they form a necessary link between text-books on chemistry and physics and the more specialized treatises on the principles and practice of chemical engineering. The aim of such a book, therefore, should be to correlate individual operations and reactions, and the complete processes which are built up from them, in such a manner as to emphasize the quantitative engineering aspect of large-scale work and the costs and other economic factors which have a bearing upon market values.

To form such a link, Prof. R. N. Shreve has contributed a new work on the chemical process industries of America. In compiling this volume, the author has followed established procedure to the extent of allocating separate chapters to individual or connected groups of industries; thereafter he has followed a well-defined plan, whereby, with the aid of energy and material flow sheets, the logical sequence of operations required to transform raw materials into saleable products is clearly demonstrated. By this means the interest of the reader is sustained and the descriptions of industrial procedures, however condensed, are not devoid of reality.

The book contains thirty-nine chapters, of which all but three are devoted to process industries. The accounts are based upon American practice and the statistics relate almost entirely to the home market. The English reader has, therefore, constantly to bear in mind the difference in economic conditions in respect of availability of raw materials, and energy and labour costs, between the two countries. The wide field embraced by the title and the limitations of space have necessarily involved a degree of arbitrary selection of subject-matter, and in some instances, an inadequate treatment.

At the present time, particular interest is attached to those comparatively new industries which, through the incidence of war, have undergone an accelerated growth. Of these the synthetic fibre and rubber industries have profoundly affected American economy and have not been without repercussions on British markets. The plastics and petroleum industries have also developed new techniques and have made available ranges of new products which are now finding widespread applications. The account given by Prof. Shreve of these war-time advances is both stimulating and informative.

The chapter on pesticides, on the other hand, fails to do justice to what is perhaps one of the most significant developments in technology in recent years. Elementary insecticidal and fungicidal agents have long been known and employed with success in the wine, fruit- and vegetable-growing industries; but a need has arisen for more refined products possessing lethal and toxic properties greater than those commonly in use to-day. In this connexion the discovery of D.D.T., 'Gammexane', neonicotine and other substances having selective toxic properties has opened up possibilities of scientific pest control of immense importance. There are, however, some formidable technical and engineering problems associated with applications in the field, which are at present engaging the attention of agriculturists and which must be solved before full advantage can be reaped from these new discoveries. It is to be regretted that the author has not given a more comprehensive treatment of this aspect of the subject.

In several instances, reference is made to new undertakings based upon the recovery of minerals from sea-water. The problems involved in this branch of technology are full of interest to the chemical engineer. The low concentration of salts, the large quantities of raw material to be handled, and the narrow margin of costs available for processing, are factors which necessitate the most rigid scientific control of processes and exceptionally high plant efficiency.

The remaining chapters deal with the major heavy and fine chemical industries according to the usual classification. It would appear that while few changes in the fundamental methods of manufacture have occurred in recent years in America, increasing attention has been given to improving the efficiencies of the unit operations upon which they are based. Transportation, phase separation and energy conservation have been extensively studied, and a better understanding has been obtained of the principles of plant lay-out.

Prof. Shreve has added short historical notes to the accounts of the various industries, and has appended to each chapter an adequate bibliography.

D. M. NEWITT

EMOTION AND ILLNESS

Emotions and Bodily Changes

A Survey of Literature on Psychosomatic Interrelationships, 1910–1945. By Dr. Flanders Dunbar. Third edition. Pp. lix + 604. (New York: Columbia University Press; London: Oxford University Press, 1946.) 50*s*. net.

AFTER the First World War it was generally agreed that symptoms such as paralysis, tremors and morbid anxiety might be the expression of mental experiences rather than the result of ultramicroscopic lesions in the central nervous system, but a sharp line was drawn between the organic and the psychogenic. For most of us the psychogenic was something that could, if necessary, be consciously simulated. This clear-cut idea was challenged in 1935 when Flanders Dunbar collected a wealth of data suggesting that physical disease might be initiated or at any rate accelerated by emotional events. The idea was not new. It is, and always has been, the belief of lay people, and a generation ago it was expressed and practised with conviction by the physician Groddeck. The hostility of the majority of the medical profession to the acceptance of psychological interpretations of organic disease is not because this is a new idea, but because it is a very old one, and because the advance of medicine since the time of Hippocrates has been largely due to a prejudice against the belief that disease could be explained by demoniac possession, emotional experiences or mental influences.

One picks up the third edition of Dr. Dunbar's treatise in the expectation of discovering how far the psychosomatic attitude to illness has advanced from suggestion to demonstration, and one is frankly disappointed, for this is just a reprint of the 1935 work with a new introduction. Now the first edition may have been a significant event, but it was not in the same category as William James' "Varieties of Religious Experience". In other words, it was a bibliography of an uncritical literature and not a classic, and no very useful purpose will be served by rattling these old bones again. Great things have happened in orthodox medicine in the last ten years, and it would be helpful to know whether corresponding progress has been made on the psychosomatic side. In so far as it has ensured a greater respect for human personality and an increased interest in the life-history of patients, the psychosomatic theory has done good. It has also the merit of being less dangerous to those on whom it is practised than other theories of disease, such as phlogiston, intestinal intoxication or focal sepsis; but like these previous theories it tends to be used as a facile explanation of conditions we do not understand. The Zola-esque writing of case-histories and the description of disease temperaments have been mistaken for a causal analysis of illness, and it sometimes seems that all that has happened is that whereas in the old days we said a man was passionate because he had red hair, nowadays we say he has red hair because he is passionate.

All this is unfortunate at a time when a lot of young men are coming out of the medical services with the idea that there is something in psychosomatic medicine. Of course there is, as anyone knows who has had much to do with the treatment of asthma or eczema. It is high time we began to try to find out what this is instead of mouthing big phrases such as 'psychobiologic unit'. A collection of the 'gilt-edged' work that has been done in this field, as by Wolf and Wolff on the stomach or Sir Thomas Lewis on urticaria, is overdue and, *pace* Dr. Dunbar, it would not be very large. We might find that whereas mental experiences, being part of the environment, influence all disease processes; their effect is most obvious in conditions in which muscular tone and glandular secretion play a predominant part. In the second edition Flanders Dunbar made the astonishing statement that it was not worth while to bring the book up to date as "nothing in the general point of view would be altered". Until that point of view is altered, professors of medicine will find it difficult to recommend text-books on psychosomatic medicine to their students, and will wish to see them well disciplined in psychiatry, genetics and statistics before they penetrate into this ill-defined field.

L. J. WITTS

BIBLIOGRAPHY OF MATHEMATICAL TABLES

An Index of Mathematical Tables

By Dr. A. Fletcher, Dr. J. C. P. Miller and Prof. L. Rosenhead. Pp. viii + 451. (London: Scientific Computing Service, Ltd., 1946.) 75*s*.

IT is common knowledge now that the tabulation of mathematical functions, and the whole approach to numerical mathematics, have been revolutionized within the present century by the increased use and improvement of calculating machines. In Britain we have seen the effects of this in the productions of Dr. L. J. Comrie and of the British Association Tables Committee; in Germany in the work of Dr. J. Peters; in the United States in the tables produced by Prof. H. T. Davis and his collaborators and, most recently and strikingly, by the New York Work Projects Administration. The old classical tables, beginning in the late sixteenth and early seventeenth centuries with Rheticus, Pitiscus and Briggs, revised, corrected, re-edited from time to time, already formed a literature in themselves; the modern and contemporary tables form an enorm-

ous and ever-increasing supplement. Descriptions of extant tables had been given in the past, for example, by De Morgan in his articles written for various encyclopædias and by the numerous reports of the British Association Tables Committee, beginning with Glaisher's extensive report of 1873, of 175 pages; but latterly the need of a comprehensive index of tables had begun to be felt. The authors of the present book set to work in 1939 to supply this need. In the United States the same need was independently experienced, the result being the publication in 1943, by a Committee of Mathematical Tables and Aids to Computation, of the quarterly journal, *Mathematical Tables and Aids to Computation*, which has very quickly justified its existence.

The "Index of Mathematical Tables", which we here review, is of outstanding value. Its price is not at all excessive, when the wealth of its contents and the beauty of its printing are considered. It is not a complete index, the compilation of which would be a task of prohibitive difficulty, but with its aid, and particularly through the bibliography, one should be able to trace and appraise all mathematical tables of genuine importance over an extraordinarily wide range of tabulated functions. Of special value is the running commentary on the subjects treated and on the accuracy of the tables.

The book falls into two parts, Part 1 being an index of tables, of 372 pages, in twenty-four sections according to the functions tabulated, Part 2 being a bibliography of seventy-two pages. In addition, there is a long introduction of great interest and instructiveness, describing in detail the arrangement of the work, the general principles and the abbreviations used.

As to the functions tabulated, we may exemplify by choosing two sections: Section 5, Mathematical Constants; Multiples and Powers; Roots of Algebraic and Transcendental Equations; Miscellaneous Constants; Conversion Tables: Section 14, Factorial or Gamma Function, Psi Function, Polygamma Functions, Beta Function, Incomplete Gamma and Beta Functions. Should one want, to thirty or more digits, the authoritative values of all the familiar constants, and a host of unfamiliar ones, their powers, their logarithms, here they all are, in elegant black type. Or if one is interested in the binary quadratic forms of integers and in the remarkable numbers $\exp(\pi\sqrt{D})$ of Hermite, here are the values for $D = 22, 37, 43, 58, 67, 163$, as calculated by Peter Gray, Ramanujan and D. H. Lehmer. The last is worth record here, its value to 39 digits being 262 537 412 640 768 743·999 999 999 999 250 072 597.

As to the thoroughness with which the authors have checked the tables, a single partial quotation, one of hundreds of the same kind, will serve. It concerns the value x_0 giving the main minimum of $\Gamma(1 + x)$.

"It has been stated in Legendre 1814 (71) and 1826 (436), and quoted by various authors, that the main minimum occurs at $x_0 = 0{\cdot}46163\ 21451\ 105$, and that $\log_{10}(x_0)! = \bar{1}{\cdot}94723\ 91743\ 9340$. Davis 1933 (278), however, gives $x_0 = 0{\cdot}46163\ 21450$. Calculations to about 25 decimals by J. C. P. Miller give (retaining 15 decimals)

$$x_0 = 0{\cdot}46163\ 21449\ 68362, \ldots .$$
$$(x_0)! = 0{\cdot}88560\ 31944\ 10889$$

The natural value of $(x_0)!$ is wrongly given as 0·88560 24 in Gauss 1813 (at any rate as reproduced in *Werke*, 3, 147, 1866). The correct 7-decimal value is given in Bertrand 1870 (284), Carr 1886 (364) and Hayashi 1926 (273), 1930b (53, 155)."

Such information in regard to errors in extant tables is visible on almost every page and is of the greatest value.

Enough has been said to show that this "Index" will henceforth be indispensable to all self-respecting centres of computation. The highest praise must be given not only to the industry, but even more to the resolution, of the authors, for completing their project during the most difficult years of the War, and amid a heavy pressure of war duties and anxieties. The book is published by the Scientific Computing Service under Dr. L. J. Comrie, and in the clearness of arrangement and the beauty of typography is in all respects up to the standard associated with this name.

A. C. AITKEN

PHILOSOPHY AND ÆSTHETIC CRITICISM

The Basis of Criticism in the Arts

By Prof. Stephen C. Pepper. Pp. xi+177. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1945.) 14*s*. net.

THIS book is of the nature of a philosophical experiment; an instructive one, well worked out, but like many experiments less simple than appears at first sight. Prof. Pepper selects (for reasons discussed in another book—"World Hypotheses", 1942) four types of philosophy as "relatively adequate world hypotheses", and uses them for the purpose of æsthetic criticism, arguing in terms of concrete examples.

The critical examination of a work of art and the interpretation of the judgments made about it bring one up against what is ultimately and irreducibly given in experience in such a way that issues cannot be dodged by selecting a few more manageable elements and ignoring the rest. The method should be valuable. The author's conclusion appears to be that each kind of world hypothesis brings out some special significant aspects and that from all of them together something like a synthetic view may emerge. The reviewer's conclusion is more one-sided. One theory comes out of the test badly: the one that, starting from the truism that beauty causes pleasure, refuses, ostensibly, to say more and is found borrowing its standards of judgment surreptitiously from other theories. What the author calls the formistic theory, the assertion of external, 'objective' standards, looks like several theories, not one. Two theories come out much better, as providing out of their own resources æsthetic criteria which are relevant and significant. But these are closely related philosophies, the fundamental distinctions of which are æsthetic, not moral, scientific or anything else. They are the type loosely called Hegelian idealism and the philosophy derived from Prof. Dewey, which the author calls contextualist. The conclusion would appear to be that the fourfold classification needs revising.

There are a number of excellent points in this stimulating discussion which cannot be dealt with in a short review, but it would be unfair not to mention the really admirable treatment of the subject of definition, a useful corrective to the distortions of some recent logicians.

A. D. RITCHIE

Library Resources of the University of North Carolina

A Summary of Facilities for Study and Research. Edited with a Foreword by Charles E. Rush. (University of North Carolina Sesquicentennial Publications.) Pp. x+264. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1945.) 21*s*. 6*d*. net.

WITH the exception of a chapter on the role of the library in the advancement of scholarship, by L. R. Wilson, professor of library science and administration, and another on co-operative facilities in research and service, by C. E. Rush, director of libraries, this volume in the sesquicentennial celebration series of the University of North Carolina is a purely factual but well-written account of the library resources of the University and its facilities for study and research, as well as of the development of the library and of its more distinctive collections of material. The chief emphasis is placed on the role of the library in the promotion of culture and scholarship, and the contribution of the library in teaching, investigation and research is well displayed.

Although there are a score and a half of contributors, the volume does not lack unity; in style and content it is admirably designed for the purpose it seeks to serve, and the production is no less appropriate. British readers handling this well-printed book, with its good paper and binding, will envy a university able to devote so much material and labour to such a purpose. There is, indeed, room for such publications in Great Britain, even on a more modest scale. A new edition of Colonel Newcombe's "The University and College Libraries of Great Britain and Ireland", now twenty years old, would scarcely meet the need, but if each British university could put out some account of its library resources intermediate in scale between the present volume and, for example, the admirable "A Reader's Guide to the British Library of Political and Economic Science", a useful addition would be made to the bibliographic tools of research and a first step taken towards that survey of library resources which the Library Association suggested in a recent report. R. B.

Report of the Michigan Academy of Science, Arts and Letters

Vol. XXVI, containing papers submitted at the Annual Meeting in 1940. Edited by Eugene S. McCartney and Mischa Titiev. Pp. xiii + 586 + 36 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1941.) 28*s*. net.

THIS volume contains papers covering a wide field in botany, zoology, geography, geology, anthropology, economics and non-scientific subjects. Most of the botanical papers are of taxonomic interest and deal with local flora in Michigan. The zoological section contains some papers of general interest, including one by M. G. Whitney on "The Hermaphrodite Gland and Germ Cells of *Vallonia Pulchella* Mull.". A second paper by Sister M. F. Xavier O'Reilly deals with "Leucocytic Reaction to Bacterial Infection in Animals". This is a contribution from the Department of Zoology and Institute for Medical Research of the University of Michigan and gives a detailed account of the injection of *Staphylococcus aureus* into earthworms, crayfish, yellow perch, goldfish, garter-snakes, turtles, pigeons, guinea pigs, rabbits and mice. Mice were also inoculated with suspensions of lampblack and fibrin in order to compare the reactions of the leucocytes to an infecting organism, and to particulate matter (lampblack) and a foreign protein (fibrin). The reactions of leucocytes in a variety of animals to the presence of an infecting organism indicate that in each class of animals a particular set of reactions is induced to protect the animal against bacteria and their metabolic results. The features associated with phagocytosis are described in detail and fall into three categories: (1) phyocytosis and excretion; (2) phagocytosis and digestion; (3) basophilia of the granules of the polymorphonuclear neutrophils or their homologues, the pseudoeosinophils.

Basic Mathematics for Radio Students

By F. M. Colebrook. Pp. x + 270. (London: Iliffe and Sons, Ltd., 1946.) 10*s*. 6*d*.

COMPETITION and diversity among text-books is surely to be desired, and it is time that the dominance of a few names in the field of educational mathematics and its applications should be challenged. The present author is correct in stating that in mathematics it is the first steps which count. Many students fail to achieve their proper stature in applied science because of the non-acquirement of facility of expression in mathematical terms, for, again quoting the author, mathematics is the generalization of experience. For such students mathematics was dull, and the present author seeks to obviate the possibility of such a defect.

His technique is to start at the very beginning and to develop a whole course of instruction based on concrete instances, titillated with engaging literary references, leading through series, limits, vectors, and some calculus, with a final application to electric circuits found in radio engineering. Not an entirely original conception; but the author manages to be rigorous at every step as far as he goes, and uses all ingenuity to induce the student to be rigorous also. There are ample examples, but no index. So we conclude that a substantial gap in the literature for teaching potential engineers has been filled.

L. E. C. HUGHES

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1945. Edited by Dr. M. Epstein. Pp. xvi + 470. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 42*s*. net.

THE arrangement and allocation of space in this annual volume remain unchanged. Rather more than half the space is devoted to the political history of the world for the year, with special reference to Great Britain and the United States both of which are treated with singular impartiality even in the record of the change of British Government in the summer of that year. It was a year of turbulence but hope. The international complications that now loom so large were only beginning to arise and the successful end of war was the dominant note. Yet the editor's task cannot have been easy; and his untimely death as this volume was being published will be widely regretted.

The second part of the book as usual gives a survey of literature, science and finance, etc., a chronicle of events and a number of obituary notices. Among the public documents printed in full is the text of the declaration of the defeat of Germany signed at Berlin on June 5, 1945, the Russo-Polish Treaty of April 1945 and the Russo-Chinese Treaty of August 1945.

POWER PRODUCTION BY NUCLEAR ENERGY

A CONSIDERABLE measure of agreement was revealed at the discussion on power production by means of nuclear energy held in the hall of Jesus College, Oxford, on August 30 as part of the International Conference arranged by the Atomic Scientists Association.

Lord Cherwell, who opened the discussion, held that great harm has been done by the exaggerated stories which have appeared in the Press, suggesting that these new sources of energy would usher in the millennium. As only about one twentieth of the national effort in Great Britain is devoted to producing and distributing power, and the greater part of this is in costs of distribution, there would be only a small gain even if power could be produced at no cost at all by atomic energy, and of this there is at present no prospect whatever. To pretend, as has been suggested, that it would lead to a 4-hour day or 20-hour week is, therefore, manifestly absurd. On the other hand, these tales have provided an admirable opportunity for every country in the world to produce bombs under the guise of developing atomic energy. He doubted whether Governments would have provided the large sums of money which had been made available in various countries for nuclear research if this had been merely directed to civil use; it seemed to him that the military aspects were the driving force and the industrial applications were the excuse. Why otherwise should expenditure on purely peaceful research, that is on metallurgy, or on plastics or on getting power from sunlight, which would probably yield a bigger return than expenditure on nuclear energy, be on such a comparatively small scale if indeed it were incurred at all by many governments?

There would probably be valuable applications of atomic power production for special purposes, such as warships or even ordinary ships, or opening up desert countries; and great benefits would accrue from the use of tracer elements, and possibly there might be direct medical applications. For these reasons, research and development should, of course, proceed. But scientific workers should combine to decry the exaggerated tales which are going the rounds. They provide the excuse for any government minded to make bombs to insist on building large piles, and thus to make international inspection and control very much more difficult than would be the case if it were frankly recognized that such activities could be postponed without serious loss to the various nations. It is so vital to the survival of civilized life on the earth that some form of control be established, that anything which stands in the way of this should be avoided.

Prof. M. L. Oliphant, who was the first speaker in the ensuing general discussion, laid stress on the importance of finding a new source of power, particularly so far as Britain is concerned, now that there is so much reluctance to mine coal from the narrow seams prevalent in Great Britain. In certain other regions, for example, parts of Australia, a thousand miles or more from the nearest coal-field, some alternative source of power would be especially valuable, exposed as they are to such a variety of industrial vicissitudes. On the other hand, the uncertainty of being able to obtain the necessary amount of uranium to produce any notable addition to world power supplies was mentioned, and it was emphasized by Prof. F. Simon that it may well be easier to derive energy from sunshine if a comparable effort in research and development were to be made. Indeed, he cast some doubt on the reality of the fuel shortage, observing how wastefully energy as a whole is used, not only in our inefficient domestic heating, but also in industrial processes. It seems to be generally agreed that the benefits to be expected from the use of nuclear energy would be in the main due to its special characteristics of great concentration per unit of weight and unit of volume, rather than to the total energy to be derived from fissionable elements.

Some of the foreign representatives (in particular Dr. L. Kowarski and Prof. F. Perrin from France) said that their countries were only interested in the power project and had no intention of making bombs; Prof. Oliphant thought it would be desirable to adopt this same line in Great Britain. Dr. H. L. Anderson told the Conference that atomic power was taken very seriously in the United States as being an important development the effects of which were likely to be felt quite soon, and that large industrial firms were pressing to have the whole matter thrown open to private enterprise to develop. A pile specially designed for production of useful power was being built, and it was expected that it would be possible to run a turbine within a year. But, of course, there was no promise that this would be an economic proposition.

Everybody agreed about the great importance of the use, for investigations and research, of radioactive tracer elements which may be obtained in abundance from piles. But many felt, as Dr. S. Devons pointed out, that fissionable elements might well prove more valuable to humanity on account of developments totally unforeseen than merely as substitutes for our present sources of power.

On the whole, the discussion proceeded on sober lines, and the balanced view prevailed that the world is not entering upon an 'atomic age' in which power would be plentiful and cost virtually nothing, but that atomic energy has great possibilities which should be explored and developed.

HUMAN ECOLOGY IN RELATION TO THE PHYSICO-CHEMICAL FACTORS

A DISCUSSION on "Human Ecology in Relation to the Physico-Chemical Factors" was held at the Royal Society on May 30.

Prof. J. B. S. Haldane, who opened the discussion, pointed out that a human environment may be specified by the time of exposure to it, and by its various constituents, which may be scalars (for example, partial pressure of a gas or temperature) or vectors (for example, acceleration). There are safety regions within which less than a certain fraction of those exposed are affected in a specified way. Human response to some variables is far less constant than to others. He instanced the wide differences in response in subjects exposed to high-pressure oxygen and the variability in response of the same subjects on different exposures. On the other hand, the response to low oxygen pressure is much more constant between individuals and on successive exposures.

Many factors, such as carbon dioxide and high-pressure oxygen, interact to increase the reaction for some values and decrease it for others. Thus carbon dioxide added to high-pressure oxygen increases the severity of reaction, but 3–5 per cent of an atmosphere of carbon dioxide will reduce the symptoms of moderate anoxia. Carbon monoxide and anoxia are additive in the reaction produced at moderate pressures, but at high pressure animals can survive high carbon monoxide concentration.

The difficulty of measuring the reaction produced in human subjects is considerable; in the response to high oxygen pressure, twitching of the lips often precedes generalized convulsions and has been used as a measurable end-point in many experiments, but is not reliable. In the case of anoxia, the conditions under which 50 per cent of subjects retain consciousness for a specified time can be used as a safe end-point.

Prof. D. Brunt then outlined the optimal conditions of climate for human comfort. He suggested that the ideal outdoor climate would permit a clothed man (*a*) to walk at 3 m.p.h. in bright sunshine without sweating appreciably, and (*b*) to rest in bright sunshine or to stand in the shade doing light work in air movement of 17 ft./minute without body cooling. This necessitates at 60 per cent relative humidity an air temperature not exceeding 68° F. for (*a*) and not less than 66° F. for (*b*); the optimum temperature is 67° F. A nude man should require a temperature 4° F. higher. The upper limits of tolerable conditions are set when the body is unable to prevent rise of rectal temperature, and heat stroke may occur.

Increasing air speed allows greater temperatures to be tolerated, but the highest wet-bulb temperature which can be tolerated falls with increasing dry-bulb temperature. When the comfort limits are surpassed, the rate of rise of body temperature is determined by the wet-bulb temperature almost independently of the dry-bulb temperature. But for comfort the dry-bulb temperature is important. He instanced the use in India of water-soaked curtains over doorways, the effect of which lowers the dry-bulb temperature without affecting the wet-bulb temperature. Very many years experience show that this method of cooling the air inside buildings is very effective in increasing comfort.

Prof. Brunt discussed equations relating heat loss to the physical factors involved in climate for both comfort and avoidance of heat stroke under various conditions. He pointed out that the 70° isotherm runs through many of the centres where early civilizations developed, and suggested that until man began to be able to control his indoor environment he was restricted to the neighbourhood of that isotherm.

The physiology of men working in a very hot environment was considered by Dr. E. A. Carmichael, who illustrated this from recent research at the National Hospital, Queen Square, London. The reaction of a man in a hot environment depends not only on immediate conditions but also on his previous experience. When a man from a temperate environment is suddenly exposed to heat, his heat-regulating mechanism at once reacts to the situation; but there is also a slower adapted process resulting from repeated exposure or when living in the tropics. This acclimatization raises the level for efficient physical or psychological work and for breakdown. The unacclimatized man shows great increase in heart-rate, blood flow to the skin increases, and the rectal temperature rises. At 94° F. wet bulb, circulatory collapse may occur and the man faint. The heart-rate at successive exposures rises less and there is less liability to faint as adaptation of the cardiovascular system occurs. This may be partly due to an increased blood volume.

Sweating is the most important control of temperature in a hot environment. With acclimatization, sweating commences at a lower rectal temperature and the rate of sweating increases. Under severe conditions with subjects at work, sweating may reach 60 c.c. per minute for short periods. With longer exposure sweat loss decreases and the salt concentration of it rises. This is suggested as due to fatigue of the sweat glands, as less osmotic work has to be done in the production of sweat with increased salt content. This fatigue of the sweat glands during work becomes less after many days continuous exposure. This may be due to hypertrophy of the glands, an increase in the number functioning, redistribution of blood or endocrine activity. This stresses the need for adequate replacement of fluid and salt. If not made good, heat cramps following a fall in plasma chlorides may occur. Acclimatization appears to occur in the same way in subjects repeatedly exposed in a hot chamber and in those living in the tropics.

Limiting conditions for psychological efficiency are lower than those for physical efficiency. The effective temperature scale does not emphasize the very narrow limit at high wet-bulb temperatures between effective temperature allowing efficient work and that producing breakdown. Nor does it sufficiently emphasize the deleterious effect of still air on working men. The experiments and observations under desert conditions show that men left to themselves drank water insufficient to replace their fluid loss although satisfying their thirst. It is questioned whether thirst is an accurate index of water needed, and it is necessary to force water and salt intake; this should be done until the daily urine secretion exceeds 500 c.c.

Dr. B. H. C. Matthews then described human tolerance and reaction to low partial pressures or oxygen, both as seen on rapid ascent in aircraft, in low-pressure chambers and on mountains.

The tolerance limits of low oxygen pressure are very different in acclimatized men; thus climbers have reached 28,000 ft. on Mount Everest. This height produces unconsciousness in a few minutes and death in less than an hour in men acclimatized to sea-level. The symptoms seen in man due to low oxygen pressure are due primarily to the reactions of the central nervous system. Peripheral tissues are little affected at oxygen pressures producing unconsciousness. The abnormalities of increasing severity from 10,000 ft. to 20,000 ft. are those of the central nervous system, particularly the higher functions. Above 20,000 ft. unconsciousness may be expected in a large proportion of subjects after a short interval. Above 25,000 ft. there is considerable possibility of death if the exposure exceeds 15 minutes.

The oxygen saturation of the blood is not the only factor in producing symptoms. Subjects vary in the degree of hyper-ventilation in response to oxygen lack, and this leads to varying degrees of alkalosis caused by the lowering of carbon dioxide in the blood by hyper-ventilation. Following hyper-ventilation, convulsive movements are common. Subjects not exhibiting much hyper-ventilation

frequently become unconscious without exhibiting hyper-excitability of the nervous system. Subjects at 22,000 ft. breathing air may become unconscious for a minute or less when given pure oxygen; this may be a reaction to the change in acidity of the blood brought about by sudden oxygenation.

By acclimatization a man is able to live and work at altitudes up to 18,000 ft. for long periods. The ultimate tolerance of the acclimatized subject is at present unknown. The principal changes that are seen are an increase in the oxygen capacity of the blood and red cell count, increased pulmonary ventilation with a lowered carbon dioxide level in the blood, the alkalosis being compensated by the kidneys to restore the *p*H to normal with a lowered alkali reserve; this takes many days for full development. Finally, changes in tissue oxidase systems occur, so that the performance of a man with an oxygen saturation of, say, 60 per cent improves greatly if he is acclimatized. The relative sensitivity of the respiratory centre to low oxygen and to changes in carbon dioxide partial pressure shows wide individual variations.

Human tolerance of acceleration depends on the posture of the body and the axis along which acceleration acts. For accelerations acting from feet to head, unconsciousness is produced if the acceleration exceeds about seven times that of gravity for five seconds. This limit is determined by failure of the circulation to maintain blood supply to the head. It is preceded by failure of vision. For shorter durations, much higher accelerations can be tolerated. For 0·1 sec., twenty times gravity can be tolerated if the body is adequately supported. The limit here is set by the mechanical strength of the body, for at high values of acceleration the large forces accelerating the body may lead to disruption of its parts.

Dr. G. L. Brown considered human tolerance to oxygen, nitrogen and carbon dioxide at raised partial pressures. Any of these may poison the central nervous mechanism of man. He emphasized the wide variation in individual tolerance and the day-to-day fluctuation in a single subject even when living under strictly standardized conditions. The prevention of convulsions through high oxygen by the use of anti-convulsants has not been successful in man. High oxygen concentration poisons enzymes concerned in carbohydrate metabolism of the brain; protective agents effective in isolated brain slices have not yet been extended to man. The cerebral intoxicant action of high partial pressures of carbon dioxide have become a serious problem in some forms of diving. Experimental work shows that 15 per cent carbon dioxide causes unconsciousness in all subjects provided that sufficient oxygen is present. If the oxygen is also low, the experiment is terminated by a feeling of suffocation and inability to maintain the large tidal volume.

There appears to be an additive effect between carbon dioxide and nitrogen intoxication. Poisoning with carbon dioxide at high oxygen concentrations closely resembles the effect of very low oxygen pressure. Performance of skilled tasks deteriorates, but convulsion, the common result of high oxygen pressure alone, is never seen. The effect of nitrogen at 10 atmospheres pressure resembles that of a general anæsthetic. The intoxication produced prevents clear thinking or performance of skilled tasks. The initial symptoms are of short duration, but there remains mental impairment of which the subject is unaware.

After exposure to toxic levels of oxygen and carbon dioxide, however, symptoms develop after return to normal conditions. Acute intoxication with carbon dioxide (15 per cent) leaves little after-effect, whereas 6 per cent carbon dioxide, which can be tolerated for hours, evokes severe effects on return to air. Vomiting and severe headache are very common. Withdrawal of nitrogen associated with a fall of pressure may lead to bubble formation within the tissues, with serious consequences. There is little evidence of any adaptation as a result of repeated exposure, and little evidence of sensitizing effects.

Sir Joseph Barcroft summed up the discussion, stressing the similarities in human reaction to any large change in his normal environment. All appear to lead to failure of co-ordination of activity in the cerebral cortex, thus producing symptoms in patterns that are often closely related; he suggested that a common factor lies behind all the reactions described, namely, that the cells of the brain are unable to continue their normal carbohydrate oxidations when the physico-chemical state of the blood supplying them is displaced from normal in any direction.

A quantitative human ecology must take into account the interaction of numerous environmental factors, and the variability of the response, as well as the influence of acclimatization or sensitization. Work done by various groups of physiologists in connexion with the War constitutes the beginning of such an ecology.

B. H. C. MATTHEWS

THE CONVERSION OF CAROTENE INTO VITAMIN A

By DR. R. F. HUNTER

THE conversion of β-carotene into vitamin A which occurs *in vivo* is represented in many standard works by means of the hydrolysis equation:

$$\underset{\beta\text{-Carotene}}{C_{40}H_{56}} + 2H_2O = \underset{\text{Vitamin A alcohol}}{2\,C_{20}H_{29}.OH}$$

Apart from the fact that we can trace no example of a hydrolytic fission of such a type in the literature, various *ad hoc* experiments on the hydrolysis of colloidal solutions of β-carotene with water, aqueous organic solvents in the presence of mild alkali and various emulsifying agents such as lecithin, sodium cholate, and polyglycerol esters, under pressure, have failed to furnish any evidence of the formation of vitamin A alcohol[1]. The mechanism of conversion is still obscure, but the 1 : 2-ratio for biological activity of α- to β-carotene[2,3] and the similar 'half activity' of semi-β-carotenone[4] and cryptoxanthin[5] indicate that this involves fission of the central double bond of β-carotene[6].

It is generally assumed that the site of the conversion is the liver. Moore[7] showed that when massive doses of carotene were fed to rats, it persisted apparently unchanged throughout the alimentary tract while high concentrations of vitamin A appeared in the liver. The storage of vitamin A in this organ, which plays an important part in regulating the concentration of the vitamin throughout the rest of the body, indicates that it is intimately connected with the process. Moreover, when the liver is poisoned or damaged[8], there is a decrease in vitamin A forma-

tion. The experiments of With[9] on the analysis of the livers of rats killed at different intervals of time after receiving high dosage of carotene, which show that conversion occurs after two hours, are also regarded as indicating that conversion takes place mainly in the liver. On the other hand, Sexton, Mehl, and Deuel[10] have observed that relatively large amounts of carotene may remain in the liver of the rat after its parenteral injection without being utilized although the animal is suffering from vitamin A deficiency. They suggest the possibility that conversion does not take place in the liver, and that the intestinal wall may be the site of the transformation.

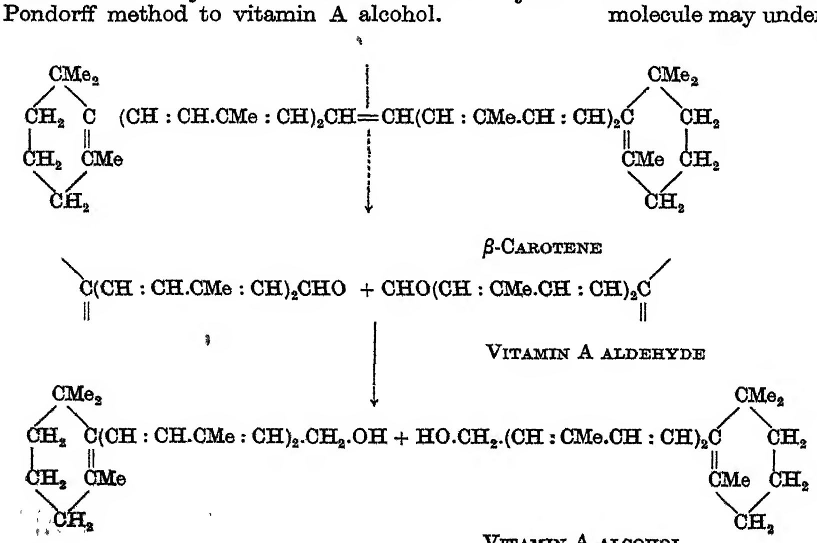
The bile acids appear to function as carriers of carotene across the intestinal wall (cf. ref. 8).

Many attempts have been made to accomplish the conversion of carotene into vitamin A *in vitro* by means of biochemical agents. The results have invariably proved to be of a negative or indefinite character. In 1931, Olcott and McCann[11] claimed to have isolated an enzyme from the liver of rats fed on a vitamin A-free diet which converted a colloidal solution of carotene into vitamin A. A little later, Pariente and Ralli[12] stated that they detected an increased response to the antimony trichloride reaction after incubating a colloidal solution of carotene with minced dog liver. Olcott and McCann's paper was criticized by Woolf and Moore[13], and a re-investigation of their experiments by Drummond and Rea[14] failed to substantiate their claim. Negative results were also obtained by Drummond and MacWalter[15], even when the liver cells were allowed to take up carotene from the circulating blood before the minced preparation was incubated. The later claim of Wilson, Ahmad and Majumdar[16] with regard to the conversion in liver autolysates is not supported by spectroscopic evidence. Further work carried out by Sir Jack Drummond and his collaborators has also furnished negative results.

It appears probable that the conversion which occurs *in vivo* involves oxidative attack of the central double bond of β-carotene with the formation of vitamin A aldehyde[17], or a product afterwards converted to this, which is reduced to vitamin A alcohol in a subsequent stage. A purely *chemical* conversion of carotene to vitamin A which suggests itself is therefore direct oxidation of β-carotene to vitamin A aldehyde and reduction of this by the Pondorff method to vitamin A alcohol.

Preliminary attempts to carry out the desired oxidation by means of a variety of reagents proved unsuccessful, and a careful repetition of Euler, Karrer, and Solmssen's[18] oxidation of β-carotene with alkaline potassium permanganate, which furnished the biologically active β-*apo*-2- and β-*apo*-4-carotenals, failed to reveal the presence of any vitamin A aldehyde. Finally, the reaction was accomplished, in very small yield (0·5–1 per cent), by means of hydrogen peroxide in glacial acetic acid under carefully controlled conditions[19]. Hydrogen peroxide suggested itself to us as a closer approach to biological conditions than other oxidizing agents, and it is interesting to note that the apparent optimum temperature of our experiments (38–40°) was near that of the animal body. The vitamin A aldehyde, which was separated from the mixture by chromatography, showed the characteristic absorption maximum in the antimony trichloride reaction and furnished the vitamin A alcohol on reduction with aluminium *iso*propoxide. The concentrate of vitamin A alcohol obtained by chromatography of the reduction product showed an absorption maximum at 620 mμ in the antimony trichloride reaction and was characterized by conversion into anhydro- or 'cyclized'-vitamin A by treatment with alcoholic hydrochloric acid[20]. A biological test of a solution in arachis oil of the vitamin A thus obtained showed growth-promoting activity in rats (ten litter-mate growth comparisons) of the order indicated by spectroscopic assay.

Numerous attempts to increase the yield by variation in the experimental conditions of oxidation of β-carotene proved unsuccessful. This is explicable on the basis of considerations of resonance in extended conjugated systems, since each double bond should lose some of its double-bonded character to the neighbouring single bonds, and the effect should increase towards the centre of the system[21]. If resonance of the conjugated system is responsible for the low yield of vitamin A aldehyde, and the *in vivo* conversion does indeed proceed by way of the latter, some circumstance must be present which obviates this effect and permits at least 50 per cent conversion, under favourable conditions, in the rat. This may be connected with a favoured geometrical configuration of the β-carotene molecule which is in equilibrium with the all-*trans* form; or possibly, the carotene molecule may undergo some form of induced polarization which renders the central double bond more susceptible to attack.



β-CAROTENE

VITAMIN A ALDEHYDE

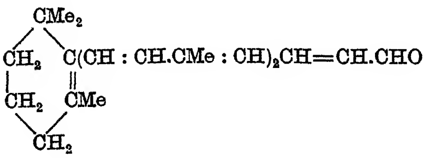
VITAMIN A ALCOHOL

Oxidation of a mixture of β-carotene and ψ-α-carotene gave a yield of vitamin A aldehyde similar to those obtained with β-carotene itself, and there was no substantial difference between the results of oxidation experiments made with freshly re-crystallized β-carotene and samples which had undergone slight atmospheric oxidation.

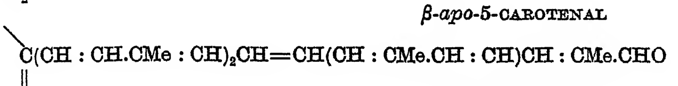
Evidence was obtained of the formation of the higher homologue of vitamin A aldehyde, β-*apo*-5-carotenal, alongside the former during oxidation of β-carotene which furnished the corresponding alcohol showing a band at 690 mμ in the anti-

mony trichloride reaction. This, however, differed from vitamin A_2 in that on 'cyclization' it gave a substance showing fine structure in the ultra-violet with absorption maxima displaced some 25 mμ into the region of longer wave-length from those of 'cyclized' vitamin A_2[22].

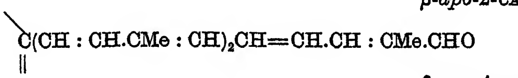
It is significant that oxidation of β-*apo*-2- and β-*apo*-4-carotenal by hydrogen peroxide in acetic acid under similar conditions to those used in the case of β-carotene failed to yield any detectable quantities of vitamin A aldehyde.



β-apo-5-CAROTENAL



β-apo-2-CAROTENAL



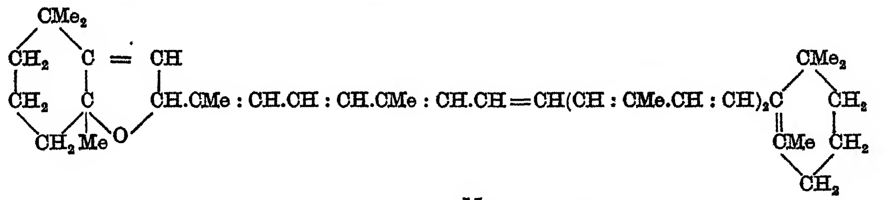
β-apo-4-CAROTENAL

These *apo*-carotenals differ from vitamin A aldehyde (β-*apo*-6-carotenal) in possessing a methyl group on the carbon atom adjacent to the aldehyde group, but their failure to furnish vitamin A aldehyde is in agreement with the supposition that the latter is formed by direct fission of the β-carotene molecule.

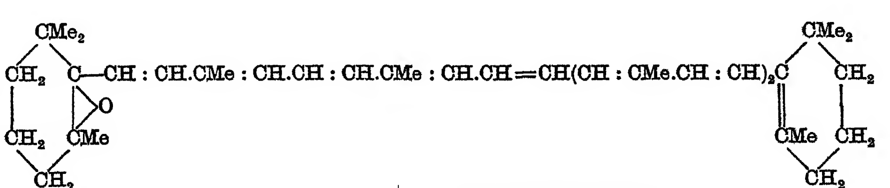
As was pointed out some years ago[6], any picture of the *in vivo* conversion involving attack of a double bond in β-carotene other than the central double bond with the production of two fragments, one of which is already too small to yield vitamin A

$$C_{40}H_{56} \rightarrow C_{20}H_{29}.OH + \text{decomposition products},$$

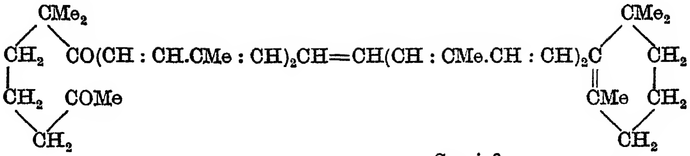
is open to objection from more than one point of view. Since it is the β-ionone ring which is preferentially attacked in the oxidation of α-carotene[17], the latter would be expected to be biologically inactive on the basis of such a mechanism of conversion of β-carotene into vitamin A. Furthermore, it would necessitate quantitative conversion of β-carotene into vitamin A in order to account for potencies in the neighbourhood of 3 million international units per gm. for the pure vitamin, which seems unlikely in a biological process in which basal diet plays such an important part. Kuhn and Brockmann's observations[4] that semi-β-carotenone shows growth-promoting activity in rats in daily doses of 5–10 μgm. is further evidence on the point, since oxidative degradation might be expected to proceed more readily from an already disrupted β-ionone ring.



MUTATOCHROME



β-CAROTENE EPOXIDE



Semi-*β*-CAROTENONE

Further but more precise evidence of a similar type is provided by the quantitative biological assay of the pro-vitamin A activity of mutatochrome[23], which Euler, Karrer and Walker[24] originally supposed to be β-carotene epoxide ('β-carotene oxide') (see below).

A four-point assay, involving 87 rats, designed and interpreted in accordance with modern statistical principles, indicates that mutatochrome has certainly less than 47 per cent, and probably less than 39 per cent of the activity of β-carotene[25].

With regard to the general problem of oxidation of β-carotene, recent experiments[26] indicate that in both arachis oil and benzene solution, gaseous oxygen attacks the terminal double bond of the conjugated system yielding β-carotene epoxide, which isomerizes to mutatochrome which undergoes further oxidation to semi-β-carotenone. Further oxidation results in the attack of the second terminal double bond of the conjugated system with the production of aurochrome and β-carotenone (formulæ as mutatochrome and semi-β-carotenone respectively with both ionone rings oxidized).

There is much evidence that the effective utilization of carotene in the animal body is intimately connected with the presence of the glycerides of unsaturated fatty acids[27], and it seems likely that the latter, in conjunction with an enzyme, play a significant part in rendering the central double bond prone to oxidation. The work of Sumner[28] on the relation between carotene oxidation and enzymatic peroxidation of unsaturated fats is of particular interest. Carotene is only slowly oxidized by peroxides of linseed oil, whereas its rapid oxidation in the presence of the enzyme from soya bean requires simultaneous peroxidation of the unsaturated fat.

The complexity of the problem of the mechanism of conversion of carotene into vitamin A *in vivo* is

indicated by the variety of factors which affect the biological response to carotene ; such as, for example, the effect of vitamin E in increasing growth-promoting activity in rats[29]. The effect of the tocopherol is, however, apparently due to its function as an anti-oxidant in the gastro-intestinal tract, rather than as a vitamin regulating some phase of metabolism in the tissues.

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WAR-TIME PROGRESS IN X-RAY ANALYSIS

THE third annual conference of the X-ray Analysis Group of the Institute of Physics was held during July 9–11 at the Royal Institution. It provided the first opportunity since the War for crystallographers of all nationalities to re-establish contacts and to exchange information and ideas. The chairman, Sir Lawrence Bragg, was able to welcome among about 320 members of the conference no less than seventy-five foreign visitors representing fifteen different countries. In his opening address, Sir Lawrence emphasized the inadequacy of a three-day conference for a full interchange of crystallographic news and views, and he felt that the visits to laboratories arranged for the foreign visitors during the following week, as well as the intervals between official sittings of the conference, should provide additional opportunities for personal discussions. In this spirit, too, the official dinner which took place at Frascati's on the night of July 10 was an outstanding success.

At the general meeting of the X-ray Analysis Group, Sir Lawrence Bragg reported on the previous year's activities of the Group and on the forthcoming discussions about the possible inauguration of an international crystallographic journal. The conversion factor of 1·00202 from kX. units of X-ray wave-length to A. (Ångströms) was agreed on in conformity with a similar decision by the American Society for X-ray and Electron Diffraction. Dr. W. H. Taylor reported on steps undertaken to make crystallographic X-ray tubes more readily available in Great Britain and outlined plans for encouraging and standardizing the manufacture of crystallographic instruments. Dr. A. J. C. Wilson reported on the success of the first supplement to the X-ray Powder Index and appealed for further contributions for future supplements.

During the course of the first official session, Prof. P. P. Ewald extended a welcome to the meeting on behalf of the International Union of Pure and Applied Physics. He took the opportunity to outline the purpose of the Union in promoting the interests of physicists the world over, and emphasized its special task in co-operating with its sister unions to provide the United Nations Organisation, through its scientific section, the United Nations Educational, Scientific and Cultural Organisation, with the best available advice on all scientific matters.

The summaries of the reviews and lectures given at the conference are here arranged according to the countries (in alphabetical order) in which the original work had been carried out. Owing to the diverse subjects discussed, it will be impossible to include references ; these can be obtained from Dr. W. H. Taylor (at the Crystallographic Laboratory, Free School Lane, Cambridge), who has asked contributors to supply him with one copy of all published work mentioned at the conference.

Belgium

Prof. G. A. Homès described the work on X-ray diffraction carried out in Belgium during the War. The Engineering College at Liège opened a "Centre for the Internal Physics of Metals" ; lectures held there had a marked influence on the application and development of X-ray methods for industrial purposes.

New methods and apparatus—including several new camera designs—were employed for use in metallurgical studies. Investigations were carried out on the orientation of grain boundaries, the effect of elastic stresses in steel, lattice distortions in welded materials, and on the sintering of metallic powders.

Work on non-metals included the systematic studies of P. Theys on Belgian clays and baked ceramics, and the investigations of G. A. Homès and S. Lefevre on the polymerization of phenolic plastics.

Prof. H. Brasseur, of Liège, himself elaborated some aspects of his work, which included : (*a*) The crystal structure study of a complex cyanide, crystals of which twinned so readily as to be flexible. (*b*) The study of the mineral substance of bones with particular reference to tricalcium phosphate hydrate, the structure and X-ray pattern of which closely resemble apatite. (*c*) The measurement of bond angles in some organic compounds containing two benzene rings joined by one or more intermediate atoms.

Czechoslovakia

Prof. V. Petržílka gave a brief summary of work done in Czechoslovakia, which was concerned chiefly with the study of metals ; but interest also lay in the determination of orientation of quartz crystals, and in foundry problems such as radiography (often employing radium or radon) of welds and castings.

Dr. Adéla Kochanovská described a new method for determining anisotropic deformations of polycrystalline cubic metals subjected to internal or external stresses.

Finland

Dr. J. A. Wasastjerna described how he had shown by very accurate experimental determinations of atomic scattering factors in alkali halides that, in the pure substances, the values of the mean squares of the displacements of ions from their theoretical positions are almost completely accounted for by thermal vibrations. In mixed crystals, however, his results showed that there were additional mean displacements of ions due to both long- and short-range disturbances. The experimental values of these two kinds of displacements indicated the existence of a certain degree of local order.

France

In a paper on French work during hostilities, Prof. J. Wyart described some of the advances made in the development of equipment; in particular of curved crystals for obtaining focused, monochromatic radiation, and of apparatus for high precision lattice parameter determination and for the determination of orientation of crystal lamellæ. He discussed in detail the important investigations on diffuse X-ray scattering by J. Laval; he mentioned the study by A. Guinier of the extra spots given by diamond, and the experimental work done on X-ray absorption and emission spectra by Kurylenko and Mlle. Cauchois, and went on to describe work done on reactions in solid phases, such as dissociation of oxides of cadmium, zinc and iron, and adsorption of hydrogen on palladium. He also mentioned structure determinations done on calcium, barium and strontium mixed carbonates, a Mn-As alloy and others.

Prof. J. J. Trillat, continuing the review of French work, described two new methods of electron microradiography, both of which depend upon the photographic effect of secondary photo-electrons rather than of X-rays. The first method, that of electron radiography by reflexion, enables micro-radiographs to be made on finished materials. Very thin films of the Lippmann type are applied to the surface under investigation, which is irradiated by hard X-rays. The photographs so obtained can be used to study the distribution of different metals on the surfaces of alloys and for other topographical investigations. The second method, electronic radiography by transmission, was used in order to obtain radiographs of very thin films, for example, plant tissues, paint films, etc. Here, the material was crossed by photoelectrons emitted from a metallic surface against which the film was pressed. Examples of application of both methods were shown, and further possible developments discussed.

Prof. Trillat also made a brief reference to the electron microscopes both with magnetic and electrostatic focusing which had been constructed in France.

Dr. A. Guinier gave an account of the work carried out in France during the War on the application of X-ray analysis in the fields of chemistry and metallography. He described the studies of M. Mathieu and Mlle. T. Petitpas on nitrocellulose, of Trillat and R. Tertian on the natural and synthetic rubbers, and his own work on measurement of particle size.

The metallographic work carried out may be divided into work on crystalline textures, and on the crystal structure of alloys. Under the former heading an extensive study was made by R. Jacquersson on the effect of torsion on a monocrystalline rod, and P. Lacombe and L. Beaujard studied the surfaces of single metal crystals. Under the second heading, improvements were made in the sensitivity of the detection of crystalline phases, and the use of scattering outside the selective reflexion directions for studying lattice irregularities and periodic defects.

Dr. Mladen Paic explained the principles of 'radioanalysis', namely, analysis by X-ray absorption, and its application to the study of segregation and diffusion of heavy components in aluminium alloys.

Germany and Austria

Dr. R. C. Evans, who had recently returned from an extensive tour of numerous crystallographic laboratories in Germany and Austria, was greatly impressed by the excellence of the equipment and by the generous scale on which it had been available in many diverse academic and industrial centres. It was the more disappointing that remarkably few advances in fundamental research had been achieved. A notable exception was the precision determination of electron density maps in simple structures, as for example that of oxalic acid dihydrate, where the parameter values obtained differ significantly from previously reported results. Dr. Evans painted a vivid picture of present conditions in the laboratories he had visited, where research is proceeding in the face of almost unimaginable difficulties.

Great Britain

Dr. K. Lonsdale described the work done in Great Britain during 1939–46 on the modification of scattering power of crystals due to the thermal vibration of the atoms, the changes that take place during the progressive dissociation of an alloy into its final phases, the phenomena that accompany age-hardening at various temperatures, and the causes of line-broadening on powder photographs of cold-worked metals, and of cobalt and $AuCu_3$. She referred to the extra lines on photographs of graphite, known to be due to the presence of a second structure, and to the extra reflexions, as yet unexplained, given most strongly by diamonds, the perfection of which can be demonstrated by the divergent-beam method; and finally, she described the very small changes of structure that accompany the anomalous electrical properties found in certain temperature regions for Rochelle salt, potassium dihydrogen phosphate and arsenate, and barium titanate.

In discussion, Prof. M. Born expressed a doubt if there was such a thing as a perfect single crystal larger than a thousand units in each direction, since the unsymmetrical vibrations will cause the atoms to be quite out of step over larger intervals.

Prof. J. D. Bernal gave an account of crystal structure determinations made in Great Britain during the period 1939–46. Complete structure analyses of relatively simple organic molecules and of molecular complexes yielded valuable accurate information on intermolecular and intramolecular bond character (J. M. Robertson and co-workers, Cox and Jeffries, H. M. Powell and co-workers). With more complex compounds, it is the detailed stereochemical relations that have been determined, as for example in the work on the sugars and on cholesteryl iodide.

These determinations and others have depended upon notable advances in the technique and methods of crystal analysis developed at the same time. The elucidation of the structure of penicillin (Hodgkin and Rogers; Bunn and Turner-Jones) exploited many of these advances, especially the development

by Bunn of Sir Lawrence Bragg's 'fly's eye' method, and the use of the Hollerith technique for the calculation of three-dimensional Fourier series (L. J. Comrie).

Bunn and co-workers investigated the structures of some natural and synthetic polymers. Further work was done by Perutz and by Mrs. Hodgkin and her co-workers on the internal structure of the protein molecule.

Prof. W. T. Astbury, in the third British review, spoke on fibrous proteins of the keratin-myosin group which show reversible intermolecular elasticity. He stated that fibrin, fibrinogen and the muscle protein tropomyosin, discovered by Bailey, belong to the group. X-ray work has included an analysis of the complete fibre pattern of porcupine quill by MacArthur, and a study of living muscle at various stages. The X-ray interpretation of the denaturation of corpuscular proteins as an unfolding of specific configurations is now made use of in the production of fibrous from corpuscular proteins. He mentioned work done by R. D. Preston on the structure of the plant cell wall, by Rudall on the chitin-protein complex of the insect cuticle, and by Hanes on the preparation and structure of synthetic starch.

Dr. W. Hume-Rothery showed an elegant apparatus for the preparation, in an argon atmosphere, of filings suitable for very accurate lattice parameter determinations.

Sir Lawrence Bragg gave an entertaining evening lecture on the bubble model which he has devised as a two-dimensional representation of the arrangement of atoms in a metal. It illustrated clearly their behaviour under stress and on annealing, as well as the effects of an impurity and of a dislocation in the structure. A short film showing the model in operation was seen at the end of the lecture.

Holland

Prof. J. M. Bijvoet gave an account of the X-ray crystallographic work carried out in Holland during the War (Part III, Chemistry in Wartime in the Netherlands, published under the auspices of the Netherlands Chemical Society).

Structures determined by trial and error methods based on two-dimensional Patterson syntheses have included: (*a*) the investigation of allotropic modifications (example, P_2O_5 (P_4O_{10})); (*b*) order-disorder transitions and the structures of high- and low-temperature modifications (examples, sodium nitrite, sodium cyanide); (*c*) further inorganic structures including lithium and ammonium cyanides; and (*d*) the structures of organic compounds including hexabromoethane and adipic acid.

New methods of structure determinations and further refinements of existing methods were developed. They included the use of isomorphous structures, as in the work on Br-, Cl- and CN-camphor, the application of artificial temperature factors in the summation of incomplete Fourier series, and the use of the background blackening in fluorescent Weissenberg diagrams for the determination of absorption factors.

The lattice defects and diffuse Laue spots in crystals of tetragonal tin were investigated. Work was also done on recrystallization phenomena in metallic crystals.

Important mathematical-physical contributions were also made to the theory of order-disorder transitions.

India

Sir K. S. Krishnan gave an account of the theory of electrical resistivity of metals in terms of the scattering of electron waves passing through them. On the basis of the analogy between X-ray and electron scattering, calculations of specific resistances and of the temperature changes in resistance were made by Krishnan in collaboration with A. B. Bhatia for a number of special cases. Close agreement was found between the observed and calculated effects. The large resistance of polyvalent metals in the liquid state was accounted for, and results of some interest obtained for the electrical resistivities of order-disorder alloys of the β-brass type over a wide range of temperatures.

Norway

Prof. O. Hassel described electron diffraction work in Norway on glasses and liquids, using a rotating-sector to modify the background and hence to get more detail in the low-angle range.

Sweden

The diverse researches carried out in Sweden during the War years were described by Prof. I. Waller and Dr. L. G. Sillèn. Besides developing a new type of electrical Fourier summation machine, Prof. Hägg and his co-workers at Uppsala have carried out comprehensive crystal structure studies on inorganic compounds. This and similar work reported from the Institute of Inorganic and General Chemistry of the University of Stockholm is too varied to be described even in summarized form within the space here available. At the latter laboratory some binary alloy phases had also been studied.

Prof. Waller also described the widespread use of focusing cameras in Sweden, his work on the breadth of powder lines and on diffuse, thermal reflexions. X-ray investigations on the kinetics of order-disorder transformations were carried out in the Department of Physics of the Technical University of Stockholm.

United States of America

Dr. R. W. G. Wyckoff presented a survey of the development of electron microscopes, which are now available commercially to suit both routine and research investigations, and of techniques for specimen preparation. High-speed microtomes permit the investigation of thin sections of rubber, polymers and biological tissues. The most striking advances, however, have been made in the methods of replica production, especially using oblique metal shadowing to enhance contrast. Dr. Wyckoff showed a wealth of photographs of macromolecules obtained in this way, in which the shapes and sizes of the molecules are clearly discernible. Using single crystals of virus proteins, it is possible to observe directly the molecular details of crystal formation. This constitutes a new direct method of crystal structure analysis, and Dr. Wyckoff looked forward to a fruitful co-operation between electron microscopists and X-ray crystallographers studying low-angle diffraction phenomena.

Prof. W. H. Zachariasen gave some account of the crystal chemistry of plutonium and neptunium. In the Manhattan Project he had carried out partial or complete crystal structure determinations on a large number of compounds of rare-earth elements, thorium, uranium, neptunium and plutonium. The chemical identity of most of these compounds was

deduced from their X-ray diffraction patterns, and a knowledge of the method of preparation. The elements uranium, neptunium and plutonium are closely related crystal-chemically in all known valence states. They are closely related to thorium and particularly cerium in the tetravalent state, and to the elements lanthanum...samarium in the trivalent state. A formal valency of two is shown by cerium, thorium, uranium, neptunium and plutonium in some compounds, the structures of which are of the interstitial type.

In the discussion which followed, Mr. H. S. Peiser said that some work on uranium compounds had been done in England, and raised the question of the value to be taken for the atomic radius of uranium.

Dr. D. Harker began with an account of X-ray work on metals done in the United States. He gave a short description of the work of C. S. Barett on X-ray topographs which show the variation of perfection over the surface of a crystal, and went on to mention investigations on the problem of age-hardening of aluminium-silver and gold-copper alloys. He concluded with some remarks about the mechanism of crystal orientation in iron-silicon sheet.

Prof. L. O. Brockway spoke about electron diffraction work. He described some commercial types of apparatus available in the United States, in two of which great space-saving has been achieved by using a high-frequency unit for the generation of high voltage. He gave examples of results achieved, first in the structure of organic liquids and then in the study of monomolecular layers on polished metal surfaces. He emphasized the fact that different patterns may be obtained from X-ray and electron diffraction studies of the same substance, but to get full information both techniques should be used.

Dr. D. MacLachlan described the principle of construction of a machine for the mechanical computation of two-dimensional Fourier series. It depends upon the spreading of layers of sand in sinusoidal waves over a scale plan of the unit cell, so that the height of the sand layer at any one point is proportional to its relative electron density.

AUDREY M. B. DOUGLAS (PARKER)
H. S. PEISER
BARBARA W. ROGERS (LOW)

OBITUARIES

Prof. John Laird, F.B.A.

PROF. JOHN LAIRD, regius professor of moral philosophy in the University of Aberdeen since 1924, died on August 5 at the age of fifty-nine. He had been in bad health for some time, but a paper read for him at a conference in July showed no falling off in clarity and incisive wit.

Laird was born on Deeside, not far from the birthplace of Reid, also a son of the manse. He studied philosophy at Edinburgh under Pringle-Pattison and Seth, and then went on to Cambridge, where he was a scholar of Trinity College. The idealism of his Scottish teachers was less congenial to him than the critical, analytic temper of Moore and Russell at Cambridge, though it may have helped him to avoid the extreme, where that temper turns into a one-sided and rigid metaphysics expressed in negations.

Laird's own philosophical temper is well seen in his book reviews, of which he wrote very many. He approaches each author prepared to examine his position on its merits and in its own terms, and as nearly as possible without prejudice, except a prejudice against anything sloppy, pretentious or obscure. The two volumes of his Gifford Lectures delivered in Glasgow ("Theism and Cosmology", 1940; "Mind and Deity", 1941) display that temper on the large scale. Laird set himself to examine the philosophical arguments that have been used to support theism. Carefully, systematically, relentlessly he winnows the chaff from the wheat; at the end, almost disappointed that his work is ended, and there is actually some wheat left. It seems unlikely that anybody will need to do this work again for a long time, and until that time nobody can consider himself a competent student of the subject without reading Laird. The only defect one can point to is a tendency to avoid any aspect of his subject which is not capable of clear statement in abstract terms. This kind of limitation is present, but is scarcely a defect, in his last book ("The Device of Government", 1944), an admirable elementary discussion of political theory. The work which is perhaps the most comprehensive and distinctive of any that Laird wrote is "The Idea of Value" (1929); a specially useful contribution to thought, constructive as well as critical, because so much recent philosophy is centred on the notion of value, and no previous writer has dealt with the subject as a whole.

There are few aspects of philosophy which Laird left untouched, though his main interest was in ethics; and he wrote a great deal. In these days when a reputation for profound scholarship can be earned by writing nothing or by making it unreadable, so prolific and easy a writer is suspected of being superficial. Such a judgment of Laird is entirely unwarranted. Moreover, it is hard to find any signs of carelessness or haste in his writing, and he repeated himself less than most. Four or five of his books have it in them to become classics, and it may well be that future generations will read them when contemporary works now more popular are quite forgotten.

A. D. RITCHIE

Prof. B. H. Bentley

THE death was announced on June 24 at the age of seventy-three of Prof. Bertram H. Bentley, emeritus professor of botany in the University of Sheffield. A scholar of Keble College, Oxford, Prof. Bentley secured a first class in natural sciences in 1896. Going to Sheffield as assistant lecturer in biology in Firth College, he helped to mould the fortunes of the young university and served it until his retirement in 1939. As the number of botany students under his care increased, he was appointed lecturer in botany in 1905 and eventually became head of a newly formed Department of Botany; but it was not until 1931 that the University appointed him to a full professorship.

Although of an inquiring mind and demanding a critical approach from his students, Prof. Bentley will be remembered for his teaching rather than his original work. Much influenced by A. H. Church, for whom he had the greatest respect, and by the distinguished contributions of Bower and others to the study of phylogenetic problems, his teaching was based always on a morphological approach, and he took pains to see that his students were well grounded

in this aspect of botany. The great advances in physiology and genetics which marked the later years of his life never seemed to capture his imagination in the same way.

Prof. Bentley was a real lover of plants, in the field and also in the garden and allotment which he tended with such care. He took pleasure in bringing in fresh material of all kinds for his students to examine, and was always anxious that they should not accept without question the text-book accounts of familiar plants. He showed great skill in Nature photography and illustrated his lectures with many slides of his own making. Before his retirement, a good deal of his time was spent in the devoted care of his wife who, following overstrain in the First World War, was somewhat of an invalid. His own latter years in Cheltenham were clouded by her death and by the gradual loss of his eyesight.

WE regret to announce the following deaths:

Nikolai Morozov, honorary member of the Academy of Sciences of the U.S.S.R., known for his general writings on scientific topics, on July 13, aged ninety-two.

Mr. H. G. Wells, on August 13, aged seventy-nine.

NEWS and VIEWS

Mathematics at Edinburgh: Sir Edmund Whittaker, F.R.S.

ON September 30, Sir Edmund Whittaker vacates the chair of mathematics in the University of Edinburgh, which he has held for a third of a century. Educated at Manchester Grammar School and Trinity College, Cambridge, he was second wrangler (equal with J. H. Grace), Bromwich being senior wrangler; afterwards, he was first Smith's Prizeman and he was elected to a fellowship at Trinity in 1896. Much of Sir Edmund's earlier scientific interest centred in theoretical astronomy, particularly in celestial mechanics; during 1901–7 he was secretary of the Royal Astronomical Society and in 1906 he was appointed Royal Astronomer of Ireland. Although his election to the chair of mathematics at Edinburgh in 1912 terminated his official astronomical career, Sir Edmund retains a lively interest in theoretical astronomy, particularly, in these latter days, in the problems of relativistic cosmogony to which he has made some notable contributions, among which may be mentioned his Riddell Lectures at Durham in 1941 on "The Beginning and End of the World". One of his achievements at Edinburgh was the institution of a Mathematical Laboratory in which students obtained a training in the science and practice of computing; the "Calculus of Observations" written by him in collaboration with G. Robinson (a member of his staff) is now the standard work in this field of mathematical discipline. Sir Edmund's other books are "Modern Analysis" (with G. N. Watson), "Treatise on Analytical Dynamics", "Theory of Optical Instruments" and the "History of the Theories of the Aether and Electricity". When Sir Arthur Eddington died in 1944, he left a nearly completed manuscript of a book on "The Fundamental Constants of Nature"; there could only be one choice of editor to see the book through the press, and Sir Edmund has given his time unsparingly in this cause, now nearing fruition.

Sir Edmund was elected to the Royal Society in 1905 and was awarded the Sylvester Medal in 1935. He was president of the Mathematical Association in 1920–1, president of Section A of the British Association in 1927 and president of the London Mathematical Society in 1928–29, being De Morgan Medallist in 1935. During 1939–44 he occupied with distinction the presidential chair of the Royal Society of Edinburgh; it is not too much to say that the Society owes an immeasurable debt to him for maintaining its activities at the highest level during these difficult war years. He has received honorary degrees from several universities and his knighthood in 1945 came as a fitting reward for a life of devoted service and notable achievement.

Dr. A. C. Aitken, F.R.S.

DR. ALEXANDER CRAIG AITKEN has been appointed to succeed Sir Edmund Whittaker as professor of mathematics in the University of Edinburgh.

Dr. Aitken, who was born at Dunedin, New Zealand, in 1895, graduated at the University of Otago, and went in 1923 as a research student to Edinburgh, where his subsequent life has been spent. After two years he submitted a thesis of such quality that, on the recommendation of the examiners, the Senatus awarded him the degree of D.Sc. instead of the Ph.D. for which he had entered. He was then appointed to the staff, and in recent years has attracted a steady flow of research students from all over the world. An original impetus towards numerical mathematics doubtless came from his own extraordinary powers in mental arithmetic: for the benefit of those who are not gifted in this way, one of his earliest achievements was to devise methods by which most of the problems with which the practical mathematician is confronted can be reduced to repetitions of a process peculiarly suited to an arithmometer, namely, a cross-multiplication followed by a division. His original papers of the last twenty years have effected notable advances in the theory of matrices and determinants, and the mathematical theory of statistics; and there have been occasional irruptions into other branches of mathematics, such as his remarkable theorem which comprehends in one formula Taylor's theorem and the other expansion-theorems which involve derivatives, all 'single-line' difference interpolation formulæ, and a multitude of other possibilities.

Physiology at Manchester: Prof. W. Schlapp

DR. WALTER SCHLAPP, who will succeed Prof. H. S. Raper (see *Nature* of August 17, p. 233) in the Brackenbury chair of physiology at the University of Manchester, received his early training in Edinburgh. He first studied chemistry under Sir James Walker and then physiology under Sir Edward Sharpey

Schafer, for whom he acted as assistant. After a year as Carnegie Research Fellow, at the end of which he obtained his Ph.D., he took up the study of medicine and graduated M.B., Ch.B. in 1929. In the following year he was appointed assistant lecturer in pharmacology in the University of Manchester. He was next transferred to the department of physiology as lecturer and afterwards appointed as reader in experimental physiology. For several years he has acted as assistant director of the Physiological Laboratories and as tutor and secretary to the Faculty of Medicine. Dr. Schlapp's early research work was concerned with the separation and physiological action of the active principles of the posterior lobe of the pituitary gland. More recently, among other things, he has carried out valuable work on ventricular fibrillation and, with Prof. Bentley, on the effects of pressure and anoxæmia on peripheral nerves. He is at present engaged in the study of pulse wave velocity making use of oscillographic records, and of experimental auricular fibrillation. He will bring to the chair a wide knowledge of teaching, research and administration which will be of great value.

Dr. Max Hartmann

DR. MAX HARTMANN, director of the Kaiser Wilhelm Institut für Biologie, spent his seventieth birthday on July 7 on his small farm in the Allgän. One of the outstanding personalities among German biologists of his generation, he can look back upon a fine record of original research, particularly in the field of sexuality and fertilization in Protozoa and Algæ. His investigations of 'relative sexuality' have led to very important biochemical studies of the substances produced and released by gametes and essential for fertilization in Algæ, echinoderms, molluscs and fishes (cf. Lord Rothschild's article in *Nature* of June 1, p. 720). Realizing the great opportunities opened up by the transition from the morphological to the experimental approach to biological problems, he has been singularly successful in guiding a large number of young workers to new and fruitful fields of research, inspiring them with his own enthusiasm for every great discovery made, whether in protozoology, cytology, genetics, experimental embryology or physiology. His capacity for critically sifting and clarifying the progress made is well reflected in his "Allgemeine Biologie", of which the third edition is now in the press. Dr. Hartmann was a fearless and outspoken critic of Nazism.

Tercentenary of Flamsteed

THE Rev. John Flamsteed, who in 1675 became the first Astronomer Royal, was also from 1684 rector of Burstow, Surrey, and at his death in 1719 was buried in the chancel of this parish church. It was fitting, therefore, that the tercentenary of his birth should be commemorated there, and at the conclusion of the afternoon service on Sunday, August 18, the present Astronomer Royal, Sir Harold Spencer Jones, gave an impressive address on his illustrious predecessor. In academic dress the Astronomer Royal stood at the chancel steps of the singularly pleasing church. In the stalls on either side sat the present rector, the Rev. Arthur Hackblock, and the Rural Dean, Canon Godwin, and the choir of the Women's Institute. In the background could be seen the window and tablets erected to Flamsteed's memory in 1887 by the late J. J. Tustin. The whole setting was of quiet beauty, and the occasion will be long remembered. In his address, Sir Harold Spencer Jones told of Flamsteed's perseverance amid many difficulties and his firm determination that nothing but the greatest possible accuracy should come from his labours. It was listened to by a large congregation, which included representatives of the Royal Astronomical Society, the British Astronomical Association, the Royal Observatory, the Clockmakers' Company and the Newcomen Society. Flamsteed's birthplace was Denby, near Derby, and a commemoration service was also held there.

Population Policy in Great Britain

A BROADSHEET, "Population—a Challenge and a Choice", No. 251, issued by Political and Economic Planning, attempts to re-state clearly and simply the arguments for and against a determined effort to alter the population trend in Great Britain, discussing the economic prospects in relation to that trend, the internal social effects which would flow from certain trends and the effects on our international position. There is no purely eugenic argument as to the effects of population trend on the average inherited qualities of the population as a whole; but the importance of quantity in relation to the distribution of age-groups and in relation to the best training and use of the raw materials of population is emphasized throughout. Now that our numbers are within our own control and the standard of living for women is a major interest in our national life, it is concluded that the choice of family size which would be made by parents, if they considered only their own personal and social development and reasonable standards of life for themselves, would strike too low a level to maintain our numbers. There are no reliable signs that this tendency will be arrested, and it is urged that to such factors as improved social services connected with parenthood there must be added a willing and confident acceptance of the demands which are made of us as a community if we are to play a worthy part in the world, and a new attitude to parenthood which will modify calculations of purely personal comfort or competition.

Action should be taken quickly; for the economic position of Great Britain enforces the need for a population policy. The rapid decline of population facing us in the last part of this century will involve waste of resources and endanger initiative and technical progress. Furthermore, the process of decline has serious social effects, such as an increasingly heavy proportion of old people, less flexibility in readjustment and an old people's influence in politics which tends to perpetuate a bias in their favour. The argument for an immediate population policy is decisive when the choice is related to the international field, but involves a decision as to the part Great Britain is to play in the world. Whether it is our work of training and education in East Africa, by our counsels and experience in helping the United Nations towards a peaceful and just solution of their difficulties, or in playing a leading part in the association of free British nations within the Commonwealth, the broadsheet suggests that Britain has yet a mission. In the coming era, Britain's influence will be maintained more by the economic adviser and the scientific worker than by the nineteenth-century methods of the armed soldier, and these young men cannot be provided in the numbers required from a population of thirty million.

American Philosophical Society

THE Year Book, 1944, of the American Philosophical Society covers the year January 1, 1944–December 1, 1944. During the year a radical change was made in the policy of the Society's library towards exchange and distribution of the Society's publications, based on the conviction that acquisitions for the library and the distribution of the Society's publications can be more effectively promoted through subscriptions than by the system of exchange. Under the new policy, the library receives in exchange for the Society's publications relatively little, depending rather on subscription or direct purchase of materials vital to the development of its holdings. The Library Committee is also mindful of the possibilities of current trends in library and research disciplines like those started by Binkley and recently developed by Fremont Rider in his volume "The Scholar and the Future of the Research Library". The problem of bringing the rich resources of the library to the attention of scholars and making them available for study and research has been a major concern of the librarian. Two special committees were set up during the year to assist in this way, in the special fields of American linguistics and archæology and of Americana. Of exceptional interest in this Committee's report are the notes by C. Dan Doren on the Franklin–Mecon correspondence, by G. Chinard on the strange fortune of two volumes of the *Transactions* associated with Franklin, and on the Elihu Thomson collection. The report of the Committee on Research includes a list of grants made from the income of the Penrose Fund and a summary of the grants made during the period July 31, 1933–December 31, 1944, together with reports from recipients of grants, arranged alphabetically under the classification of subjects represented in the membership of the Society. Because of the participation of many scientific men in research connected with the war effort, particularly in certain fields, the request for grants during the past two years was not as large as previously, but the Committee has not lowered the standard set for making grants.

National Foundation for Scientific Research, Brussels

THE seventeenth annual report of the National Foundation for Scientific Research, Brussels, for the year 1943–44, in addition to the report on the activities of the Foundation during the year, includes the statutes, a list of members of the scientific commission, and of publications during the year, which renders the report a most useful reference work. Reporting on eleven important projects in the field of industrial science, reference is made to research financed by the Foundation André van der Stricht on the mechanism of the degradation of nitrogenous substances contained in yeasts, malts and moulds of breweries. The Établissements Hauzeur, Simonis and Peltzer have financed a research on the physico-chemical affinity between the molecules of certain colouring matters and proteins, especially the keratins of wool. Further research is being assisted by the Fabrique de Produits Chimiques de Grammont on the preparation, improvement and stabilization of certain grades of animal black and of certain carbons and colloids constituting the active absorbents. The Belgian Institute for the Improvement of the Beet is supporting an experimental study of the causal factors of the phenomena of polyploidy in the beet, in view of its eventual systematic use in industrial cultivation. The Belgian Association for the Testing and Use of Materials is supporting an investigation on the protection of ferrous metals against corrosion, and the Optical Society of Belgium an investigation leading to the development of a photometer for the trichromatic specification of colour.

Cheshunt Research Station

THE glasshouse work of the Experimental and Research Station at Turner's Hill, Cheshunt, Herts, was interrupted by enemy action in July 1944; but a substantial amount of laboratory work was carried out during that year (Rep. Exp. Res. Sta., Cheshunt, 1944). Preliminary trials by W. H. Read show that 5 per cent D.D.T./kaolin dusts or 0·02 per cent D.D.T. sprays give good control of tomato moth caterpillars (*Polia oleracea*). Red spider mites are not, however, controlled by this new insecticide, but D.D.T. can be added to petroleum emulsion sprays and the mixture used for the control of both pests. E. R. Speyer and W. J. Parr suggest measures for the control of tomato leaf-miners (*Liriomyza* spp.). These involve steaming the soil of propagating houses before introduction of the staging, and growing plants with a harder kind of growth than normal. Magnesium deficiency of tomato has been studied by O. Owen, who finds that spraying the foliage with 2 per cent Epsom salts, plus a wetting agent, gives good control. I. W. Selman finds that Cheshunt Early Giant lettuce is most resistant to mosaic virus when grown with low nitrogen and low phosphate, with medium watering. It is unlikely, according to P. H. Williams, that *Verticillium* wilt can be controlled by altering the *p*H of the soil, as the fungus can grow well between *p*H 4·0 and 8·0. A severe loss of heliotrope cuttings, due to the fungus *Corticium solani*, is described by Mrs. E. Sheard. The report of the director (Dr. W. F. Bewley) shows that experiments on the growth of tomatoes in gravel cultures have been commenced. Trials of bulky composts were inconclusive because of damage by enemy action.

London Scientific Film Society

THE London Scientific Film Society, 34 Soho Square, London, W.1, which has been re-organised and enlarged, starts its ninth season in September. It has booked the Scala Theatre in Charlotte Street, London, for ten Sundays in the next ten months, and will show programmes of scientific and documentary films afternoon and evening. In addition it hopes to arrange for lectures and showings of research films on weekday evenings in suitable halls. It also proposes activities to organise shows of scientific films for children and to publish a small quarterly journal to be called the *Scientific Film*. The Society is also to sponsor the production of experimental films by a group of its members. Membership is open to anyone more than sixteen years old.

Size of Page in Technical Journals

A REPORT of the Technical and Trade Papers Committee of the Institute of Incorporated Practitioners in Advertising to the Trade and Technical Press, dated October 1943, was issued in May 1946 by the Institute under the title "Standardisation of Type Area Sizes for Trade and Technical Journals", with the note that the trade and technical Press has recommended its members to give serious consideration to the standardization of type-areas. The members of the Institute hope that British

periodicals which adopted reduced page-sizes as a war-time measure will as soon as possible revert to full size, but they direct attention to the opportunity for standardization that will occur when paper supplies permit this change. Out of 638 trade and technical periodicals examined by the Committee, the maximum number with any one type-area was 47; there were 242 different sizes, 144 of which were unique, and the type-areas also vary in shape. Standardization is pressed in this report from the point of view of the advertiser, who wishes to submit sketches, lay-outs and copy in as few sizes as possible; but the strong recommendation of the report in favour of the adoption of a single size, namely, 10 in. by 7 in., will be welcomed by librarians and others who have been seriously embarrassed at times by the apparent irrational changes in size of periodicals as well as by the extreme diversity. The Committee recommends adoption of this size as the one indicated by its analysis as the most generally suitable and that to which journals making a change are likely to conform. It is also to a much greater extent than any other the most approved size for American, Canadian and other periodicals published overseas. Two other sizes are also suggested for consideration: $11\frac{1}{2}$ in. by 8 in. and 9 in. by $6\frac{1}{2}$ in. The proposals of the report are now commended by the Institute for detailed consideration by all concerned.

Vibration Problems

In a paper read before the Institution of Electrical Engineers in London recently, Dr. A. J. King considers the various ways in which vibration manifests itself, namely, noise, vibration, stress and rotational oscillation. The available methods of measuring vibration are described and their relative merits and limitations discussed. Methods of calibrating measuring apparatus are given, with an indication of their limits. The suppression of vibration is considered from the points of view of what is desirable, how much can be obtained at the source and how much by resilient mountings, attention being given to the effect of ground and source impedance. Practical examples are given of the reductions in vibration which have been achieved in certain cases by improvements in the source and by resilient mountings. The second part of the paper is concerned with the determination of elastic design data on resilient materials and mountings for use as described earlier for reducing vibration transmission. The limitations of a previous moving-iron-drive resonance-type method are discussed, and the advantages of a moving-coil-drive co-ordinate-potentiometer method are pointed out. The apparatus is described in detail, and results of tests on typical materials and mountings are given and discussed.

Mites as Carriers of Typhus

The British Museum (Natural History) has issued a useful pamphlet, in its Economic Series (No. 16), by Dr. Susan Finnegan entitled "Acari as Agents Transmitting Typhus in India, Australasia and the Far East" (from the Museum. 1*s*. 6*d*.). The typhus fever group of diseases, it may be added, includes a number of affections occurring under diverse climatic and biological conditions throughout the world. They are all due to the activities of minute, non-filterable, rod-like bodies of the genus *Rickettsia*. Excluding epidemic louse-borne typhus, these diseases are known, or suspected, to be carried by larval mites of the family Trombidiidæ or by ticks of the family Ixodidæ. The most important infections spread by Acari are 'rural' typhus, tsutsugamushi or 'scrub' typhus; tick typhus or 'Kumaon fever' of India; the so-called 'Q' fever of Queensland; Rocky Mountain spotted fever of North America and others. The carriers are definitely known in but few cases, though the available evidence points to Acari as being the main vectors. This naturally has led to the great importance of correct identification of any species suspected in this connexion. Dr. Finnegan in this pamphlet has provided an admirably clear and well-illustrated guide to the subject which can scarcely fail to be of real use to medical officers and others in lands where typhus occurs.

Varieties of Red and White Clover

Watkin Williams (*Bull. Welsh Plant Breed. Stat.*, No. 16, 1945) has outlined the results of the recent work on clovers which has been carried out at the Welsh Plant Breeding Station, largely under the guidance of the late R. D. Williams. This painstaking work emphasizes the necessity of an analysis of the characteristics of the existing types, judicious selection of the characters desired and the practical production of suitable methods for the isolation of commercially desired forms. Both in red clover and in white clover, the Welsh Plant Breeding Station has been able to produce improved strains which are outstanding for commercial purposes.

University of London Appointments

The title of reader in civil engineering in the University has been conferred on Dr. L. A. Beaufoy in respect of the post held by him at King's College. The title of reader in chemistry in the University has been conferred on Dr. D. J. G. Ives, in respect of the post held by him at Birkbeck College. The title of reader in history and philosophy of science in the University has been conferred on Dr. Douglas McKie, in respect of the post held by him at University College. The title of professor of morbid anatomy and histology in the University has been conferred on Dr. R. W. Scarff, in respect of the post held by him at the Middlesex Hospital Medical School.

The title of professor emeritus of civil and mechanical engineering in the University has been conferred on Prof. E. H. Lamb, who held the chair of civil and mechanical engineering at East London College (now Queen Mary College) from 1913 until his retirement at the end of the session 1944–45 (see *Nature*, **156**, 137; 1945). The title of professor emeritus of helminthology in the University has been conferred on Prof. R. T. Leiper, who retires in September 1946 from the William Julien Courtauld chair of helminthology at the London School of Hygiene and Tropical Medicine, which he has held since 1917. The title of professor emeritus of experimental pathology in the University has been conferred on Prof. E. L. Kennaway, who retires in September 1946 from the chair of experimental pathology at the Chester Beatty Research Institute of the Royal Cancer Hospital, which he has held since 1931 (see *Nature*, **158**, 51; 1946).

Erratum. In the communication "Nutritional Value of High-Extraction Wheat Meals" by A. R. P. Walker, Prof. J. T. Irving and Dr. F. W. Fox in *Nature* of June 8, p. 769, the percentage of calcium absorbed during week 2 on usual diet (see table) should be 26, and not 36 as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of X-Rays on the Rate of Turnover of Phosphatides

IONIZING radiation produces chemical effects on the irradiated tissue which often lead, after a very appreciable lag, to extensive morphological changes. It is of interest to investigate which chemical processes are involved in the immediate effect of the ionizing radiation.

At an earlier date[1] it was found that the rate of turnover of desoxyribonucleic acid is diminished under the influence of X-rays. This was shown by using radiophosphorus as an indicator. From the ^{32}P content of the desoxyribonucleic acid and that of the inorganic phosphorus isolated from Jensen sarcoma of the rat, it was calculated that of a hundred desoxyribonucleic acid molecules extracted from the sarcoma 2 hours after administration of labelled phosphate, about two had been built up in the course of the experiment. If irradiation with several hundred r. units preceded the administration of labelled phosphate, the corresponding figure was decreased to a half to a third of the above value. The effect of X-rays on the rate of turnover is temporary, disappearing with time. The phenomenon of recovery of the nucleic acid cycle from the effect of X-rays is of importance for the understanding of the different sensitivities of growing and full-grown tissue to the effect of X-rays. In the latter case the average cell is very much further from the mitotic stage than in the growing tissue, and thus has time to recover its normal nucleic acid cycle before any appreciable change in the nuclear structure takes place. This is not the case in the growing tissue where, in the absence of a normal nucleic acid cycle, an anomalous nuclear development takes place with all its far-reaching consequences.

It is not only the rate of turnover of desoxyribonucleic acid that is diminished under the action of X-rays. A similar behaviour is also shown by the phosphatide turnover, as seen from the accompanying table.

EFFECT OF X-RAYS ON THE TURNOVER OF PHOSPHATIDES OF THE CELL NUCLEI AND ON THE TOTAL TISSUE OF THE JENSEN SARCOMA AND THE LIVER OF THE RAT. AVERAGE WEIGHT OF RATS, 150 GM.

Groups of 12 rats	Activity of 1 mgm. phosphatide phosphorus as a percentage of the activity of 1 mgm. inorganic tissue phosphorus					
		Nuclei	Tissue		Nuclei	Tissue
Controls	*Sarcoma*	2·86	3·75	*Liver*	10·34	20·44
Controls		2·38	2·37		8·15	11·25
Controls		2·75	2·67		11·33	14·25
Irradiated		2·56	2·32		3·29	12·30
Irradiated		1·02	1·52		4·08	8·91
Irradiated		1·44	1·41		4·83	8·20
Percentage decrease due to irradiation		37	38		59	36

To groups of twelve rats, after irradiation with 1,000 r., labelled phosphate is administered, and control groups are treated in a similar way. After the lapse of 2 hours, the sarcomata and livers are pooled separately. An aliquot is used in the determination of the specific activities of the inorganic and phosphatide phosphorus of the tissue, while from the bulk of the material cell nuclei are isolated by the method of Dounce[2]. The specific activities of the corresponding phosphorus fractions of the nuclei are also determined.

As seen from the table, the rate of turnover of the phosphatides in the nuclei is markedly diminished under the effect of X-rays and that in the cytoplasm is also diminished (the greater part of the phosphatides of the tissue is present in the cytoplasm).

No appreciable difference is found between the rates of renewal of phosphatides present in the nuclei and in the cytoplasm of the sarcoma. In the nuclei of the liver, however, the rate of renewal of phosphatides lags behind the rapid turnover of these compounds in the cytoplasm. The question of a possible interchange between the phosphatide molecules of the nuclei and those of the cytoplasm is under investigation.

While irradiation of the sarcoma diminishes the rate of turnover of the total phosphorus of the tissue by 10 per cent only, the corresponding value for the sarcoma nuclei is reduced to a third of its normal value. This result is partly to be explained by the comparatively high content and rate of turnover of the desoxyribonucleic acid phosphorus and phosphatide phosphorus of the nuclei of the sarcoma.

I wish to express my thanks to Prof. H. von Euler for numerous facilities kindly placed at my disposal, to Prof. M. Siegbahn for the radiophosphorus used, and to Miss Marianne Andersen for very efficient assistance.

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June 23.

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Sensitization of Muscle to Choline and Acetylcholine, and the Supposed Existence of Choline Acetylase

NACHMANSOHN and his colleagues[1,2] and Feldberg and Mann[3] have suggested the enzymatic synthesis of acetylcholine from choline and acetate in the presence of adenosine triphosphate. The alleged enzyme has been named choline acetylase. The authors used the m. rectus abdominis of frogs to test the quantity of synthetized acetylcholine.

Repeating their experiments, we found that the contraction of m. rectus abdominis of frogs and of the dorsal muscle of leeches in response to choline, concentration $1:10^{-3}$–$1:10^{-4}$, is greatly increased in the presence of adenosine triphosphate ($1:10^{-4}$–$1:10^{-5}$), this increase depending on the concentration of adenosine triphosphate. In an earlier communication[4] we described the same effect of adenosine triphosphate upon muscle contractions produced by acetylcholine.

Since this effect of adenosine triphosphate was not taken into consideration by the authors mentioned above[1,2,3], the increase of observed muscle contraction may possibly have been due not to the stimulation of acetylcholine synthesis by adenosine triphosphate, but to the sensitizing effect of this substance upon the test-muscles.

The sensitizing effect of adenosine triphosphate is also of interest in connexion with the observations of Binet and Minz[5], Bergami[6], Feldberg[7], and others, concerning the sensitization of muscle to acetylcholine in the presence of extracts and emulsions of nerve tissue. It is possible that this sensitization is due to the adenosine triphosphate present in these extracts. Further data on this matter will be given in a separate communication.

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The Pancreas and Alkaline Phosphatase

IN various accounts of histochemical studies on the presence of alkaline phosphatase (substrate: sodium-β-glycerophosphate, *p*H 9) in homologous organs, correspondences (for example, in kidney and intestine) have usually been stressed rather than differences. It seems, however, appropriate to direct attention to the latter in order to place the value of experiments on animals in its proper perspective. If the pancreas is selected for discussion, it is because of the confusion which seems to exist in the literature concerning the phosphatase content of this organ. It is often stated in a general way that the enzyme occurs or has been shown to be present in pancreatic tissue[1,2]. The fact is that Grosser and Husler[3], who investigated the pancreas of cattle, sheep, cat and man biochemically, expressly emphasize the complete absence of the enzyme. Again, Takamatsu[4], and Kabat and Furth[5] failed to produce histochemical evidence for the presence of phosphatase in the pancreas of man. Gomori[6] reported that only in the pancreas of the dog are the smallest ducts strongly outlined in black (phosphatase-positive). I found[7], in histochemical tests, the epithelial cells, which are related to the duct system of the external secretion of the pancreas, entirely negative in the guinea pig and rat, but strongly positive in the dog (from the centro-acinar cells to the epithelium of large ducts; Fig. 1), thus confirming and extending Gomori's observation.

More recent studies on the rabbit showed that in this species, too, the duct system gives a definitely positive reaction, though somewhat less extensively than in the dog, the centro-acinar cells and smallest ducts being mainly affected (Fig. 2).

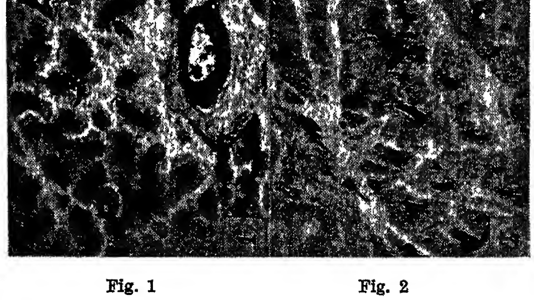

Fig. 1 Fig. 2

FIG. 1. FROM PANCREAS OF DOG. CENTRO-ACINAR CELLS, SMALL DUCTS AND A LARGER DUCT HEAVILY PHOSPHATASE-POSITIVE (BLACK). × 100

FIG. 2. FROM PANCREAS OF RABBIT. MAINLY CENTRO-ACINAR CELLS POSITIVE. IN BOTTOM-LEFT CORNER IS PART OF A LARGER DUCT THE EPITHELIUM OF WHICH IS NEGATIVE. × 100

Nothman's interesting discovery[2] of the presence of phosphatase in the pancreatic juice of dogs and its increase after ligation of the duct with subsequent rise of the level of serum phosphatase is, therefore, in full accord with the histochemical distribution of the enzyme in the pancreas of that species. Similar behaviour can be predicted for the rabbit. But caution is necessary in applying such results from animal experiments to clinical tests, and Nothman's suggestion that the level of serum phosphatase might be used as a diagnostic aid in pancreatic diseases (for example, duct occlusion) seems to be based on the erroneous assumption that a state of affairs exists in the human pancreas similar to that of the dog.

The cells of the acini themselves are histochemically negative with regard to phosphatase in all the species examined. It would thus appear that in the two 'positive' species (dog and rabbit) the epithelial cells of the duct system, particularly its finest ramifications, are responsible for the secretion of the enzyme. This interpretation would rest on the assumption that the site of the heaviest histochemical reaction for phosphatase is also the site of its formation. It is, however, conceivable that the enzyme, in these two species, is actually secreted by the cells of the acini and only becomes activated when present in the duct system (including the lumina between the centro-acinar cells), and that on applying the histochemical test, the adjacent epithelial cells and their nuclei supply suitable and perhaps necessary surfaces and interfaces for the reaction to take place, which then brings about the heavy salt precipitation in these cells.

Finally, it may be added that I found the islet cells strongly positive only in the dog; in the rat the peripheral cells of the islets sometimes show a weak (brownish) and doubtful reaction.

Further details of these and other comparative histochemical studies on the distribution of phosphatase will be published elsewhere.

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Demonstration of Phosphatase in Decalcified Bone

As the decalcifying fluids commonly used in histology destroy alkaline phosphatase, it has so far only been possible to demonstrate the enzyme in undecalcified bone. The disadvantages of current methods are threefold: (1) Only bones from embryos or very young animals can give sections sufficiently thin to enable localization of phosphatase to be established satisfactorily by the method of Gomori[1] or of Menten, Junge and Green[2]. (2) If the Gomori method for bone is employed, the preformed phosphate is stained black and the site of phosphatase purple. Controls only show the black bone salt. It is extremely difficult to decide whether there are areas in which both phosphatase and bone salt occur concurrently. (3) The Gomori method suffers from the obvious disadvantage of requiring treatment of the phosphatase-containing tissue with ammonium sulphide (which is an inhibitor of the enzyme[3]) before and during incubation of the sections.

The present method permits bones of adult rats and mice to be decalcified without adverse effects on the enzyme. It is based on the facts, established by Cloetens[4,5], that alkaline phosphatase is reversibly inactivated by acid solutions having a pH greater than 4·5, and that it can be reactivated afterwards by alkaline solutions. Inactivation is retarded by the addition of Zn^{++} to the acid medium, and reactivation is aided by glycine.

It was found that kidney sections kept in acetate or citrate buffer at pH 4·4–4·6 in the presence of Zn^{++} ($10^{-4}M$) can be completely reactivated even after 14 days by treatment with 0·075 per cent glycine in 1 per cent sodium barbitone. (The glycine must be washed out before incubation as it interferes with the precipitation of calcium phosphate[3].)

Small pieces of bone fixed in 80 per cent alcohol and brought to water were left in the buffers until decalcified, the liquids being changed daily and kept at 10° C. The time taken for decalcification varied from three to fourteen days according to the size and consistency of the bone. The tissues were then washed in water, 'reactivated' for two hours in glycine-barbitone at 37° C., washed thoroughly in running water, dehydrated and embedded in paraffin (58° m.p.). Sections were cut at 8μ and the phosphatase demonstrated by the original Gomori–Takamatsu method[6,7].

The distribution thus found agrees essentially with that described by other workers[1,8]. The ground substance of bony trabeculæ or compact bone contains no phosphatase. Superficially placed osteocytes with their processes, and Sharpey's fibres, stand out black against the colourless matrix.

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Vitamin Storage and Utilization in the Organism

DR. T. K. WITH's suggestion[1] that carotenoids, such as cryptoxanthin and β-carotene, are vitamins in their own right commands considerable sympathy, but we do not think that the data advanced in that communication settle the point. The efficiency of utilization and the storage of vitamin A in the liver of the rat and the chick are affected by many factors which control the growth response or quantity found. These include the amount and kind of vitamin A fed[2], the amount of sparing agents, more particularly the tocopherols fed at the same time[3], and the idiosyncrasies of the animal[4], which is another way of saying that we do not yet know the complete physiology of vitamin utilization and liver storage.

We believe that the high value of utilization of cryptoxanthin by the chick may be explained completely by the large quantities of γ-tocopherol and other covitamins and sparing agents which are present in yellow corn. At least Dr. With's contentions would be considerably strengthened if the exact contribution made by the sparing agents could be measured.

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Effect of Röntgen Irradiation on the Serum Content of Hæmagglutinins in Human Blood

THE behaviour of the natural antibodies present in the blood of normal individuals, under irradiation with Röntgen rays, has not been much investigated. The object of our present study was the behaviour of natural anti-sheep agglutinins in men who had been subjected to röntgenotherapy.

We have chosen as the indicator of the effect of irradiation the anti-sheep agglutinins, since in recent years this normal antibody has been the subject of extensive studies. Their standard titre in normal individuals is generally equal to the dilutions 1 : 4–1 : 8 of the serum. In our own investigations, on some hundreds of normal individuals, we have found in normal men only exceptionally a titre as high as 1 : 16. It is well known from clinical observations that the titre of anti-sheep agglutinins may rise considerably in some definite conditions, particularly in infectious mononucleosis and after injections of horse serum (normal or immune). In the first condition we have seen the titre in one case as high as 1 : 2,800.

The interpretation of this rise is relatively easy in serum sickness, as horse serum belongs to Forssman's antigens. In the case of infectious mononucleosis, the rise of the titre may be due to an unknown etiological agent, which is acting as Forssman's antigen, or to some unspecific stimulation of the reticulo-endothelial system. The clinical and experimental work of this Institute has shown that X-rays in small doses act as a powerful stimulant of this system. In our observations we therefore studied the possible influence of radiological stimulation of the reticulo-endothelial system on the titre of anti-sheep agglutinins.

In all we have had under observation thirty-two persons, who received röntgenotherapy for different causes: cancer, leucæmia, inflammatory states, and so on. Dosage varied from 50 r. to 6,000 r. In no case did the titre of sheep agglutinins after irradiation rise above the dilution of 1 : 10; it therefore remained normal.

These observations show that X-rays do not influence the behaviour of normal anti-sheep agglutinins; hence the rise of the titre in some conditions probably does not depend on the stimulation of the reticulo-endothelial system, but on active immunization.

The first appearance of hæmagglutinins in infants at the age of four to six months (earlier on artificial than on breast feeding) is probably due to changes of the intestinal flora at this period, some intestinal micro-organisms acting as Forssman's antigen.

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Nutritional Studies on Blood-sucking Arthropods

A GREAT deal of study has been devoted in recent years to the nutritional requirements of insects, particularly those of economic importance. Blood-sucking insects, however, have suffered neglect, although they present problems of unusual interest. We have undertaken investigations on the rate of development of nymphs of the bed-bug, *Cimex lectularius* L., and of the fertility of the resulting adults, by feeding them directly on a number of different hosts or *in vitro* through a membrane.

It was found possible to rear first instar bugs to the adult stage by feeding them on defibrinated hæmolysed blood through a mouse skin membrane. Attempts to vary the nature of the diets fed through the membrane were hampered by the refusal of the bugs to consume many of the diets offered them. Moreover, slight changes in the composition of the blood, such as slight dilution with isotonic saline solution, resulted in the death of all the nymphs by the time the third instar was reached. In spite of these difficulties, it was possible

...ablish that growth, survival and fertility were impaired in varying degrees by using the freshly drawn defibrinated hæmolysed blood of various animals. Restoration of the fibrin to the blood, the use of stirred unhæmolysed defibrinated blood or storage of defibrinated hæmolysed blood at − 5° C. increased its toxicity to the bugs. Separated blood fractions such as cells and serum were inadequate for growth and proved highly toxic.

When the nymphs were fed directly on a rabbit, even drastic blood changes brought about by the injection of dicoumarol or heparin had only a slight effect on the rate of growth of the bugs, but increased the mortality. There is thus a remarkable contrast between the ease with which media are rendered unsuitable for bugs *in vitro*, and the difficulty of affecting growth by changes in the blood of the host *in vivo*. This difference was most clearly shown by injecting rabbits with large doses of penicillin and then feeding bugs on the blood *in vivo* and through a membrane. Bugs fed directly on the rabbit grew normally, but when fed *in vitro* on the rabbit's blood they died. This effect could not be attributed to the penicillin, since tests carried out an hour after feeding revealed no trace of penicillin in the bugs; the dietary blood still showed penicillin activity. Furthermore, no effect on the symbionts of the bugs was apparent. Direct injection of penicillin into the hæmocœl of fifth stage nymphs did not prevent them from moulting in the same time as controls injected with saline solution. The adults from such nymphs treated with penicillin contained what were apparently normal symbionts. It has been reported by Brues and Dunn[1] that in the cockroach the injection of penicillin serves to eliminate the symbionts.

It was thought possible to study dietary deficiency in the bug by inducing deficiency in the host. The bugs were fed on two groups of rats, which were given diets containing succinylsulphathiazole; in one group the diet was composed of purified ingredients, in the other case it was unpurified. Despite the severe leucopenia and agranulocytosis which developed in the rats on the purified diet, the rate of growth of the nymphs was not affected. However, in both groups there was a reduction in the number of eggs laid per female bug. When nymphs were fed on thiamin-deficient rats (in the blood of which no thiamin could be detected on assay) the rate of development of the bugs was not affected; but, as can be seen from the accompanying table, egg-laying was drastically reduced. Moreover, a large proportion of the eggs were sterile and of the 'taub' variety[2]. One subsequent feed on a normal rat resulted in the production, by the same adult bugs, of only two 'taub' eggs and a much higher proportion of fertile eggs.

Deficiency induced in rat	Number of first instar nymphs	Percentage reaching adult stage	Number of pairs	Mean and S.D. of number of eggs laid per female
None (normal diet)	96	67	21	10·4 ± 2·5
Folic acid	65	23	5	6·0 ± 3·3
Thiamin	45	33	7	1·3 ± 0·45
Thiamin	62	34	8	1·4 ± 1·0
Adults reared on thiamin-deficient rat given one feed on a normal rat			7	5·0 ± 4·0

Thiamin has been shown to be a dietary essential of every insect so far investigated. We have demonstrated[3] that folic acid is necessary for the mosquito larva and, more recently, Fraenkel and Blewett[4] have done the same in the case of *Tenebrio molitor* and *Ephestia kuehniella*. It is highly probable that in the experiments quoted in the table, the rat's blood contained little or no folic acid in one case and no thiamin in the other. The ability of the bedbug to develop so well under these conditions may be attributed to synthesis of folic acid and thiamin by its symbionts.

In the bedbug, the symbionts are situated in mycetocytes connected with the gonads and the fat body[5]. In order to throw more light on the function of the symbionts in deficiency, the arthropod *Ornithodorus moubata* Murray was studied. In this tick the symbionts are present in the Malpighian tubes[6,7], and might therefore be expected to serve a different purpose from those in the bedbug.

When *Ornithodorus* was fed on thiamin-deficient rats, there was a striking decrease in the rate of growth and in the size of the nymphs, even in the early stages of development. While it is too early as yet to say whether the ticks will reach maturity and if so whether they will prove fertile, there is already sufficient evidence to show that thiamin deficiency affects this arthropod far more severely than it does *Cimex*. In both instances the activity of the host was not a complicating factor.

It is of interest to mention also that the bite of *Ornithodorus* produced a much more pronounced hæmorrhagic reaction in the thiamin-deficient rat than it does in normal rats.

Our thanks are due to Miss L. O'C. Black and Miss J. P. Bradley for technical assistance and to Dr. D. Ordman for a supply of *O. moubata*.

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Application of the Paper Partition Chromatogram to the Qualitative Analysis of Reducing Sugars

GORDON, MARTIN AND SYNGE[1] and Consden, Gordon and Martin[2] have shown that good separations of amino-acids can be obtained on filter paper by allowing a suitable solvent, which has previously been saturated with water, to flow over the paper in a closed container, the air in which is saturated with the vapours of water and the solvent. Filter paper contains 20–25 per cent water under these conditions, and separation depends upon the differences in partition coefficient of the amino-acids between the stationary water phase and the moving solvent. It has further been shown[1] that for any individual amino-acid the value

$$R_F = \frac{\text{distance moved by the band}}{\text{distance moved by the advancing front of liquid}}$$

is directly related to the partition coefficient, true adsorption by the cellulose playing little part. In the present preliminary investigation, which was undertaken as a result of a discussion with Dr. A. J. P. Martin and his colleagues, the behaviour of reducing sugars on the paper chromatogram has been examined.

In general, the experimental conditions that allow of separation of the amino-acids are also suitable for the qualitative analysis of reducing sugars. The apparatus used is similar to that described by Consden *et al.*[2], for work with narrow strips of paper, except that the glass trough was replaced by one of similar pattern made from stainless steel. Whatman No. 1 filter paper was used and was cut into strips 43 cm. × 12 cm. For use with phenol or collidine, the sugar solutions used were roughly 1 per cent wt./vol. with respect to each individual sugar, and about 2–3 μl. containing about 20–30 μgm. of each sugar was introduced as a circular spot on a horizontal line ruled 7·5 cm. from the top of the paper strip. When a number of different sugar solutions were run in the same strip of paper, the spots were introduced at intervals of 1·5 cm. along the horizontal line. When *n*-butanol or *n*-butanol-ethanol mixtures were used, the sugars did not travel so far and diffusion was less marked. For this reason considerably smaller amounts (0·5–1 μl. containing 5–10 μgm.) could be employed, and this assisted the observation of separation between closely neighbouring spots.

The strips were usually run 18 hours overnight. The solvent was then dried off in an oven at 105° C., the position of the solvent boundary being marked in ink before transfer to the oven. In order to reveal the positions of the sugars, the paper was sprayed rapidly and evenly with a mixture containing equal parts of silver nitrate (*N*/10) and ammonia solution (5*N*) and the strip replaced in the oven (105° C.) for 5–10 min.; the sugars appeared as dark brown spots on a white or light brown ground. In runs carried out in phenol, the lower part of the paper was usually uniformly coloured light brown, the upper part being white. This was presumably due to a reducing substance present in the paper as an impurity. The reaction with ammoniacal silver nitrate was given by all the reducing sugars tested, including maltose and lactose which gave spots of a rather lighter shade; but under the conditions employed the colour was not given by amino-acids, cysteine or creatine. The developed strips began to darken owing to the presence of silver salts a few hours after they had been removed from the oven, and if a permanent record was desired, the strips were washed first in distilled water and afterwards in running tap water for a few hours, followed by drying.

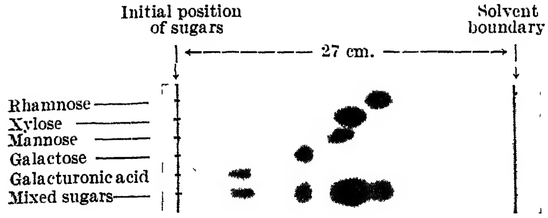
R_F VALUES OF REDUCING SUGARS IN VARIOUS SOLVENTS AT ROOM TEMPERATURE (WHATMAN NO. 1 PAPER)

Solvent	Phenol	*n*-Butanol	*n*-Butanol 45% ethanol 5% water 50%*	*n*-Butanol 40% ethanol 10% water 50%†	*s*-Collidine
Addition	NH_3*, HCN	NH_3*	NH_3*	NH_3*	
Glucose	0·39	0·070	0·105	0·185	0·39
Galactose	0·44	0·060	0·090	0·170	0·34
Mannose	0·45	0·100	0·130	0·220	0·46
Sorbose	0·41	0·085	0·120	0·200	0·40
Fructose	0·51	0·100	0·135	0·215	0·42
Xylose	0·44	0·125	0·170	0·245	0·50
Arabinose	0·54	0·100	0·145	0·215	0·43
Ribose	0·59	0·180	0·210	0·285	0·56
Rhamnose	0·59	0·220	0·285	0·345	0·59
Galacturonic acid	0·13	0·00	0·00	0·065	0·14
Glucosamine hydrochloride	0·62	0·105	0·150	0·225	0·30
Lactose	0·38	0·00	0·00	0·075	0·24
Maltose	0·36	0·010	0·015	0·100	0·32

* Ammonia was added to a concentration of about 1 per cent in the aqueous liquid at the bottom of the chamber.

† The solvents were mixed in the proportions given: the lower aqueous layer was run into the bottom of the chamber and the upper organic layer placed in the bath feeding the strip.

The accompanying table shows average R_F values obtained for a number of solvents and solvent mixtures. Temperatures varied from 16° to 23° C.; the variation in R_F value due to temperature changes was slight when phenol was used, but was more considerable with collidine or butanol-ethanol mixtures. The runs in phenol and butanol were carried out in the presence of ammonia in order to liberate the free base from glucosamine hydrochloride. In addition, a few crystals of potassium cyanide were added to the aqueous liquid in the bottom of the chamber when phenol was used, in order to suppress the catalytic oxidation of the solvent due to the presence of copper in the filter paper[1].



FILTER PAPER CHROMATOGRAM OF FIVE MONOSACCHARIDES SHOWING THE SEPARATION OF THE MIXTURE. SOLVENT, COLLIDINE. PAPER, WHATMAN No. 1. TEMP. 21–23° C.

The photograph shows the separation of a number of sugars in γ-collidine. The difference in R_F value between xylose and mannose is not great enough to result in separation between these two sugars. With phenol as the moving phase, three groups of sugars could not be separated; these were: rhamnose, ribose, glucosamine (R_F 0·59–0·62); galactose, mannose, xylose (R_F 0·44–0·45); sorbose, glucose (R_F 0·39–0·41). The use of collidine or butanol-ethanol mixtures permitted the separation of the first and second groups, provided the amount of sugar taken was not too large. Sorbose and glucose could not be separated in any of the three solvents investigated, although small differences in R_F values could be demonstrated by use of the individual sugars.

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July 12.

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Alginic Acid-acetate

VARIOUS attempts have been described[1] to acetylate alginic acid by means of acetic anhydride or acetic acid, without or with catalysts, for example, pyridine, acids, etc. Some of the products thus obtained were probably degraded, and it appeared of interest, therefore, to find out whether the acetylation of alginic acid can be done by a relatively mild method; for this reason the interaction with ketene was studied.

Alginic acid fully swollen with acetone reacts with ketene at room temperature to form a colourless insoluble ester acid which can be converted into a sodium and calcium salt. These derivatives could also be prepared by direct reaction of sodium or calcium alginate and ketene. The analysis of the various products indicates that approximately one acetyl grouping has been introduced into each repeating unit of these chain polymers. Viscosity determinations were made with solutions containing sodium alginate obtained by hydrolysis of the acetyl derivatives, and these tests lead to the following conclusions.

During the acetylation of calcium alginate, no substantial degradation appears to occur; but during the reaction with sodium alginate and particularly with free alginic acid, some degradation takes place. The viscosity of solutions containing the 'recovered' sodium alginate is in all cases far higher, however, than that of solutions of salts of low molecular uronic acids. The following polymers were tested with regard to their swelling in water:

	Moles of water $\times 10^{-2}$ bound at 20° by 1 gm.-equivalent
Alginic acid	7
Sodium alginate	∞
Calcium alginate	6
Alginic acid-acetate	5
Sodium salt of alginic acid-acetate	25
Calcium salt of alginic acid-acetate	12

It should be noted that, in contrast to sodium alginate, which is soluble in water, the sodium salt of alginic acid-acetate swells to a limited extent only. If the free ester-acid is dried and the sodium salt is made by adding, at room temperature, an equivalent amount of sodium hydroxide solution, a non-transparent gel is obtained which binds only $\sim 8 \times 10^2$ mol. water per gm.-equivalent: if, on the other hand, the sodium hydroxide solution and the fully swollen ester acid are mixed at about 60°, a colourless, transparent jelly is obtained, with a high degree of swelling (see table). An equally highly swollen transparent jelly can be made by dispersing the moderately swollen modification of the sodium salt in glycerol and adding excess water to the dispersion.

It has been found that alginic acid-acetate and its sodium salt are cation-exchange materials, that is, these colourless gels can be used either to remove certain cations, such as calcium, from dilute solutions, or as adsorption materials for inorganic chromatography.

A full account of these experiments will be published elsewhere.

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Influence of Glucose in the Assay of Streptomycin

DURING the course of our investigations into the production and properties of streptomycin, we have confirmed the majority of the observations recorded by Waksman *et al.*[1,2], Denkelwater *et al.*[3], and by Abraham and Duthie[4]. These confirmations cover thermal stability, *p*H at which optimum activity is apparent, stability in solutions on storage, and methods of inactivation, but we have obtained results which suggest that the effect of glucose, to which attention has been directed, may be more complex than has hitherto been thought.

In their work on the properties of streptomycin, Waksman *et al.*[1] indicated that two methods of assay were used: (*a*) a serial dilution method using *B. coli* as the test organism; and (*b*) a cup-plate method using spores of *B. subtilis*; and they showed that in the latter test the addition of 2 mgm. of glucose to 10 ml. of agar reduced the potency of streptomycin by one half. The suggestion put forward for this reduction[2] was that "This may be due to the reducing properties of glucose or to the production of some acid by the test organism". In this laboratory we have used mainly a ring-plate method of assay with *B. coli* as the test organism and a bile-salt-lactose agar medium. We have preferred to use *B. coli* instead of a spore-bearing bacterium, such as *B. subtilis*, because our original interest in streptomycin arose from the claims that it was active against Gram-negative bacteria. We use bile-salt-lactose agar because it gives a better defined zone of inhibition than ordinary nutrient agar made from tryptic digest broth.

Under our conditions of assay, the addition of glucose to the medium did not result in any apparent change in potency of the streptomycin. When, however, nutrient agar was substituted for bile-salt agar, a decline in potency was observed, the decline being dependent on the amount of glucose added to the medium. On the other hand, when *B. subtilis* was used in nutrient agar, a reduction in apparent potency, similar to that obtained by Waksman, was found (see table).

EFFECT OF GLUCOSE ON THE PLATE ASSAY OF STREPTOMYCIN USING VARIOUS MEDIA AND ORGANISMS

Glucose added (mgm.) per plate (15 ml. agar)	Assay (u./ml.) using *B. coli*		Assay (u./ml.) using *B. subtilis*		
	Nutrient agar	Bile-salt-lactose agar	Nutrient agar		Quoted by Waksman[1]
			Sample *A*	Sample *B*	
0 (Control)	60	60	82	80	1200
2	56	62	43	—	—
3	—	—	—	—	600
10	36	03	35	51	—
15	—	—	35	—	620
20	17	61	38	54	—
40	8	55	—	55	—

In addition to the above tests, a series of assays was carried out in which glucose was added to solutions of streptomycin (70–80 u./ml.) instead of to the culture medium. The results showed that the activity was reduced when assayed against *B. subtilis*, the activity falling from 85 u./ml. with glucose absent to 46 u./ml. when 20 mgm. glucose per 10 ml. solution were added. In the tests with *B. coli*, however, no reduction was observed in either nutrient agar or in bile-salt-lactose agar.

From these results it is evident that the effect of glucose on the apparent potency of streptomycin depends on the organism and the culture medium used in the assay. It seems doubtful, therefore, that acid production by the organism or reducing action is solely responsible for the phenomena encountered.

We have pleasure in acknowledging the active interest of Sir Jack Drummond, and the help given by Mr. C. E. Coulthard.

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July 22.

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Strong Magnetic Fields

IT is well known that with strong electromagnets one can produce unlimited magnetic fields, since the field increases with the logarithm of the dimensions of the polepieces; but in reality the field obtainable is limited by the enormous expense involved by the building of big electromagnets.

In the case of solenoids, the limit of the field is determined by the way in which the heat developed is carried away, and by the cost of the energy source; the experiments of Deslandres and Pérot have shown the order of magnitude of the strongest fields obtainable in this way.

In 1924 Kapitza succeeded in producing in an original way very strong fields of short duration by short-circuiting a battery by a small solenoid during a fraction of a second; in 1927 he improved his method by using, instead of a battery, a generator which could stand the enormous shock caused by the short-circuiting. In these experiments the small solenoid had to be reinforced, as without this precaution it tended to explode. In this way fields of short duration (about 1/100 sec.) could be produced.

By connecting a small copper coil, immersed in a bath of liquid hydrogen, during 0·1 sec. with the terminals of a very big battery, we have been able to produce magnetic fields up to about 250,000 gauss in a cylindrical space of 8 mm. diameter; the duration of one discharge is thus about ten times as long as in Kapitza's experiments. The heat developed causes the evaporation of a quantity of hydrogen, but as the resistance of the copper coil at the temperatures of liquid hydrogen is very small, and the heat of vaporization of liquid hydrogen relatively great, the amount of hydrogen required is not very big, which means that the experiments can be made in an ordinary cryostat.

The electrical equipment at our disposal did not permit us to push this method as far as possible, but the results indicate that with relatively small improvements much stronger fields can be obtained than in these very preliminary experiments.

Similar experiments have been carried out in baths of liquid helium at temperatures below the λ point. Although the development of heat was smaller in this case, the heat of vaporization of helium is also small and the fields produced were therefore not as strong as in liquid hydrogen; but an improved apparatus will certainly also yield much better results.

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Fission Fragment Tracks in Photographic Plates

THE observation of tracks due to fission fragments in photographic emulsions has been reported by a number of authors[1,2]. In the course of similar work with photographic plates, we have obtained abundant

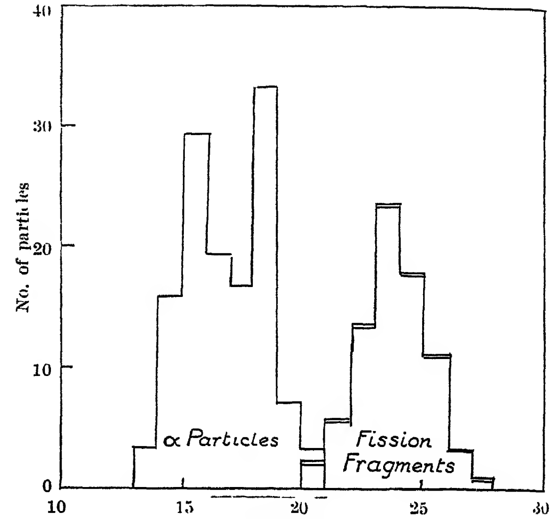

Fig. 2

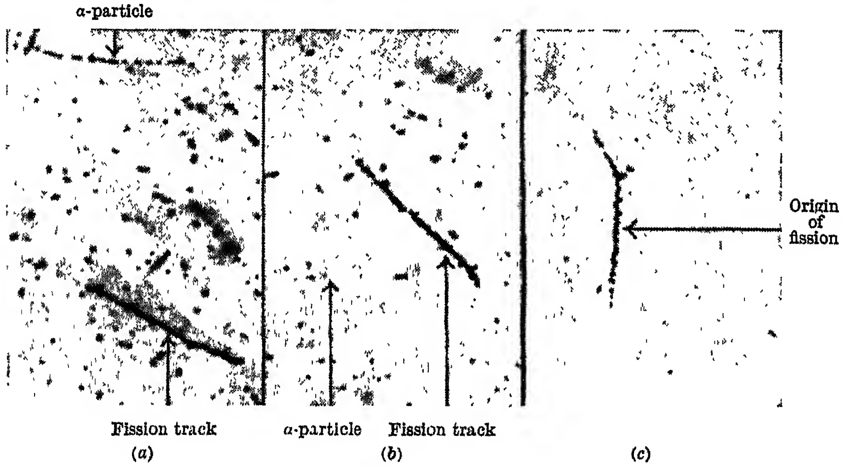

Fig. 1

and easily recognizable fission fragment tracks in specially concentrated emulsions supplied by Ilford, Ltd. The advantages of these new emulsions for the investigation of nuclear processes have already been described[3].

The concentrated plates were prepared for exposure by immersing them in ammonium uranate dissolved in dilute acetic acid. The plates were then thoroughly dried, enclosed in thin brass boxes and irradiated for three hours with slow neutrons in the Cavendish High Tension Laboratory using a lithium-deuteron neutron source surrounded by paraffin wax.

The plates were examined under the microscope in the usual way and numerous examples of fission tracks were found (see Fig. 1, *a*, *b*, *c*). In most of the plates α-particle tracks from the disintegration of uranium are also visible, but tracks due to the recoils of fast neutrons are almost completely absent. This is due to the desensitizing action of the uranyl ion on the emulsion, which also improves the differentiation between the tracks of various types of nuclear particles. At a strength of 10 gm. uranyl ion per litre, proton tracks are almost completely inhibited, α-particle tracks are weakened, but fission tracks are still prominent. Fig. 1*a* shows the marked difference of grain density between a fission track and an α-particle track at this stage of desensitization, and the considerable background of single grains present. Further increase in the strength of the uranium solution reduces the background considerably, completely prevents the formation of proton tracks, and greatly weakens the traces of α-particles. Fission tracks, however, are still prominent, as shown in Fig. 1*b*, which was taken in a plate immersed in a solution containing 40 gm. uranyl ion per litre. Measurements made of the track-lengths in a plate similar to Fig. 1*a* are plotted in Fig. 2, from which it is clear that the combined range of the two fission fragments exceeds that of the α-particle groups from uranium by a considerable margin, and this feature, together with the higher grain density of fission tracks, makes identification immediate.

A similar technique was utilized in the production of fission fragment tracks by fast lithium-deuteron neutrons in thorium. In this case the proton recoil background would normally be exceedingly dense, but this background was eliminated by soaking the plates in a 2 per cent solution of chromic acid and drying before impregnating with thorium acetate.

The fission fragment tracks exhibit several characteristic features which have been observed already[4]. There are frequent light and heavy nuclear recoils, giving forked and branched tracks, an example of which is shown in Fig. 1*c*. The grain density in the tracks decreases with decreasing energy of the fission fragment, unlike the well-known Bragg curves for protons and α-particles. This effect causes the total range to be reduced in highly desensitized plates, because the last portions of the actual range are not recorded. The abundance of fission tracks varies with the strength of the impregnating solution and the conditions of irradiation, but a typical figure of three tracks per sq. mm. per gm. of uranyl ion per litre is readily obtainable. In a highly loaded plate, therefore, it is possible to examine rapidly large numbers of fission events. The method in general has obvious advantages where it is desired to inspect the entire path of the fission tracks or to obtain information about rare fission events.

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Linear 'Curves of Best Fit' and Regression Lines

IN a recent communication, Austen and Pelzer[1] have discussed the problem of fitting a straight line when both the variables v, w are subject to error: their solution first seems to have been derived by Kummell[2] without the restriction that the standard deviations be constant throughout the range; he only assumed the ratio of the standard error of one variable to that of the other was the same for all pairs of readings. Kummell's paper does not seem to be obtainable in England, but this particular result is quoted by Deming[3]. The same solution was given later by K. Pearson and again by Gini, and there is a bibliography of work related to the subject in a paper by Roos[4]. Attention may also be directed to a recent paper by Wald[5].

It is important to distinguish between the line of 'best fit' and the regression lines. The former serves as the estimate of the constant of proportionality holding between *true* values; for example, the slope of the line of best fit of mass against volume is an estimate of the density. The regression lines, however, provide an answer to the problem: How can one variable (mass, say) be estimated from the other (volume, say)? To answer this, one takes a preliminary sample of several pairs of observations under the same conditions as will be encountered later in measuring the volume, and estimates the re-

gression line of mass on volume: from this line the mass can be found by measurements of volume under similar conditions of distributions of errors and true values to those in the preliminary sample. The regression line of mass on volume provides the best estimate of *true* mass from *observed* volume. The use of the regression line to estimate density is only valid if measurements of volume are free from error: the use of the line of best fit to estimate mass from volume or volume from mass will, in general, lead to biased estimates.

Of course, it by no means follows that if the true values are connected by a linear relation then the regression of measured value of one variable (the dependent variable) on the measured value of the other variable (the independent variable) is linear. However, it is possible to prove that under this condition the necessary and sufficient condition for linearity is that the cumulant generating function of the distribution of errors of the independent variable be a constant multiple of the cumulant generating function of the distribution of true values of the independent variable.

The estimate of Kummell's involves a knowledge of the ratio of the standard deviations β: Austen and Pelzer have suggested that, if β is unknown, one should assume $\beta = \rho$, the slope of the line, leading to the estimate

$$\rho = \{\Sigma w^2/\Sigma v^2\}^{1/2} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

It should be noticed that this estimate is, in general, inconsistent, that is, as the sample size increases indefinitely the estimate, instead of tending to the true slope, tends to another value. It is the minimum requirement of any estimate that it be consistent, and hence the use of (1) is not satisfactory; it has previously been proposed by Dent[6]. Least squares methods do not enable the slope to be estimated without a knowledge of β, and if the distribution of errors and true values are normal, then no consistent estimate of ρ can be found.

Seares's solution

$$\rho = \left\{\frac{\overline{w}^2 - \sigma_w^2}{\overline{v}^2 - \sigma_v^2}\right\}^{1/2} \quad . \quad . \quad . \quad . \quad (2)$$

requires a knowledge of σ_w, σ_v and not merely their ratio, so that as it assumes more known, I should have expected it to have given a better estimate of ρ than Kummell's.

It is hoped to publish a fuller discussion of these points elsewhere, together with a proof of the above theorem and some generalizations of it: the work has been carried out as part of the research programme of the National Physical Laboratory, and this letter is published by permission of the Director.

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Elimination of Certain Divergencies in Quantum Electrodynamics

THE 'λ-limiting process', given by Wentzel and improved by Dirac, gives a finite classical theory for the interaction of a point-charge with its own field. A new mathematical method due to M. Riesz[1,2] of solving the wave equation by means of analytical continuation gives the same finite equation of motion for a point-charge as this 'λ-limiting process'.

In previous papers we have applied these mathematical methods to quantum electrodynamics and to meson theory, solving the ordinary and the meson wave equation respectively by analytical continuation. In the following we will generalize these calculations.

We consider the interaction of an electron field ψ satisfying Dirac's equation, and an electromagnetic field A. When second quantization is used, ψ, too, becomes a matrix wave function. We work with the Heisenberg picture, with matrices varying with t and the state vector constant. The equations are

$$\left[\frac{i\hbar}{c}\frac{\partial}{\partial t} - i\hbar\alpha^i\frac{\partial}{\partial x^i} - \beta mc\right]\psi = \frac{e}{c}A_\mu\alpha^\mu\psi.$$

$$\Box A_\mu = 4\pi e\psi^*\alpha_\mu\psi.$$

We assume the usual commutation relations. The self-energy terms are, in the second approximation,

$$W = W_1 + W_2 = \frac{e^2}{2}\iiint dV\left[\psi^{0*}\psi^0 A_0{}^1 - \frac{1}{c}\psi^{0*}\vec{\alpha}\psi^0\vec{A}^1\right]$$
$$- \frac{e^2}{2c}\iiint\left[\psi^{1*}\vec{\alpha}\psi^0 + \psi^{0*}\vec{\alpha}\psi^1\right]\vec{A}^0.$$

We[3] have obtained A^1 by analytical continuation with respect to a parameter α for a certain value $\alpha = 2$. Physical expressions containing A^1 can be defined as functions of α and calculated by analytical continuation. When we apply these methods in quantum theory, some formerly divergent expressions become finite (for example, $W_1 = 0$), but other divergencies still remain, for example, the second self-energy term W_2. Introducing in addition to the 'λ-limiting process' the hypothesis of positive- and negative-energy photons, Dirac has eliminated these divergencies also.

Hitherto, we have solved the wave equation by analytical continuation and the Dirac equation in the ordinary way. The Dirac equation is also, however, a hyperbolic equation, the solution of which, and thereby the corresponding energy expressions, can be given by analytical continuation. We will calculate W_2 by this method, which has no counterpart in classical theory.

Introducing

$$x^0 = ct,\ e^0 = \beta,\ e^i = -\beta\alpha^i,\ \nabla = \Sigma e^\nu\frac{\partial}{\partial x^\nu},\ \mu = mc/\hbar.$$

we write the Dirac equation

$$(\nabla + i\mu)\psi = -\frac{ie}{\hbar c}A_\mu\beta\alpha^\mu\psi.$$

As $\nabla^2 = \Box$, we have $(\nabla - i\mu)(\nabla + i\mu) = \Box + \mu^2$.

The solution of $(\Box + \mu^2)\psi = f(P)$ is the analytical continuation to $\alpha = 2$ of

$$V^\alpha f(P) = \frac{1}{2^{\alpha/2}2\pi\Gamma\left(\frac{\alpha}{2}\right)}\iiiint_{D_S^P} f(Q)\left(\frac{r_{PQ}}{\mu}\right)^{\frac{\alpha-4}{2}} J_{\frac{\alpha-4}{2}}(\mu r_{PQ})dQ,$$

where r_{PQ} is the Lorentz distance between P and Q, and D_S^P is the four-dimensional domain bounded by the retrograde light-cone with its top in P and by the space S. Riesz[2] has obtained the α-function corresponding to the operator ∇. We now seek the functions $L_1{}^\alpha$ and $L_2{}^\alpha$ corresponding to the operators $\nabla + i\mu$ and $\nabla - i\mu$ respectively. We find

$$L_1{}^\alpha f(P) = \exp\left(\frac{i\pi\alpha}{2}\right)\left[\cos\frac{\pi\alpha}{2}V^\alpha f(P) - i\sin\frac{\pi\alpha}{2}(\nabla - i\mu)V^{\alpha+1}f(P)\right],$$

$L_2{}^\alpha f(P)$ is obtained from $L_1{}^\alpha f(P)$ by substituting $\nabla + i\mu$ for $\nabla - i\mu$. As $(\nabla + i\mu)L_1{}^\alpha f(P) = L_2{}^{\alpha-1}f(P)$ and $L_2{}^0 f(P) = f(P)$, the solution of the Dirac equation is obtained by analytical continuation to $\alpha = 1$.

We will now, *assuming positive-energy photons only*, calculate W_2 by analytical continuation. Inserting

$$\psi^{1\alpha} = (\nabla - i\mu)V^{\alpha+1}\left[\left(-\frac{i}{\hbar c}\right)A_\mu{}^0\beta\alpha^\mu\psi^0\right] + \text{(terms}$$

vanishing for $\alpha = 1$) for ψ^1 in W_2, we get an expression $W_2{}^\alpha$. Owing to A^0, the matrix wave function for the electromagnetic field in empty space, we get sums over all photons. In the one-electron case, ψ^0 contains only one term which is not zero. We perform the operation $\nabla - i\mu$. For an electron at rest the terms containing $\beta\alpha^i\frac{\partial}{\partial x^i}$ are zero. After further calculation we get for the other terms, when neglecting the retardation, an integrand which contains a sum over all photons

$$\sum_\lambda \exp\left(\frac{i}{\hbar}k_\lambda(X_Q - X_P)\right) = \delta(X_Q - X_P).$$

A calculation analogous to that for $W_1{}^\alpha$ gives[4,5] for $W_2{}^\alpha$ an expression convergent for $2 < \alpha < 4$, which can be continued analytically to all α's. As ψ has to be a solution of the Dirac equation, we have to find the analytical continuation to $\alpha = 1$. We find $W_2 = -\frac{e^2\mu}{8}$.

Thus solving both the wave equation and the Dirac equation by analytical continuation, we find without further hypotheses finite expressions for the second approximation of the interaction energy.

A fuller account of this work will be presented in the *Arkiv. f. Mat. Astr. o. Fys.*, Stockholm.

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June 15.

[1] Riesz, M., Congrès Internat. Math. Oslo, 2, 44 (1936).
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[3] Gustafson, T., *Lunds Fysiogr. S. Förh.*, 15, 28 (1945).
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Practical Control of Wireworm with 'Gammexane'

IN *Nature* of June 8, Messrs. Golightly and Hogg refer to our statement in an earlier issue that wireworm populations had been reduced by as much as 65 per cent following the application of 'Gammexane'. In view of a misconception that has evidently arisen, we would state that this 65 per cent measured *the difference between the populations of treated and untreated plots when sampled at the same time*, and had no connexion with the well-known natural fall in population that occurs after ploughing out.

We realize that the spectacular effect of 'Gammexane' treatment may not be due solely to reduction of the wireworm population, and also that other pests may sometimes be affected by these applications. It is hoped to publish a full account of our trials shortly.

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RESEARCH ITEMS

Caddis Flies of Illinois

A WELL-PRODUCED monograph on the Trichoptera of Illinois forms the subject of Article 1 of Vol. 23 of the *Bulletin of the Illinois Natural History Survey*. The author, Herbert H. Ross, mentions that some 184 species of these insects are known from the State of Illinois, and that the immature stages of no fewer than a hundred and twenty of the species are treated in this work. A considerable number of the species are described as new, and it is estimated that about three-quarters of a million specimens were actually collected and examined. Many of them were either females or larvæ, and consequently could not be identified any further than their genera. Keys are given for the identification of the larvæ, pupæ and adults of the seventeen families of caddis flies that are represented in North America. The monograph is very fully illustrated by more than a thousand separate figures of structural details which are clearly represented and greatly enhance the value of the work for purposes of identification. At the end of the monograph there is a useful check list of the Trichoptera of the nearctic zoological region. The whole treatise forms an admirable introduction to the study of these insects in North America, and is also likely to be useful to students of the European species.

Colour Changes in Feathers of Hens

THE F_1 males of barred Rock and Brown Leghorn fowls have feathers which are barred at the apex and Leghorn-like at the base. Mary Juhn (*J. Hered.*, 36, 355; 1945) has shown that when males were raised with thiouracil in their diet the shape of the feather, the pattern and especially the proportion of barring and Leghorn patterns on the feather were altered. In some cases there was a complete reversal of pattern—Leghorn apex and barring at the base. Phenotypic alterations may be brought about in the colour of feathers by depressing the metabolic level as by thiouracil. This is held by the author to support her hypothesis that patterns of genetic origin were affected by morphogenetic levels.

Interpretation of the Golgi Apparatus

NEARLY fifty years have elapsed since the cytoplasmic structure, known by the above name, was first recognized; but a generally acceptable conception of it is still lacking. L. G. Worley has published a useful critical review of the whole subject (*Ann. New York Acad. Sci.*, 47, 1; 1946). The reason for much of the uncertainty regarding the interpretation of the nature of the Golgi apparatus appears to lie, to a high degree, in over-emphasis being given to the study of fixed, stained material, and inadequate examination of the living cells. During the past few years, it has come to be realized that the Golgi bodies are to be found in most, if not all, living animal cells. The apparatus is to be regarded as a series of intracellular, sponge-like structures which on account of their peculiar chemical nature and behaviour are continually engaged in mobilizing the protein and fat reserves of the cell, some of which are transformed into specialized secretory products. It is claimed that great opportunities await the cytologist who can bring himself to realize that the Golgi apparatus is something more important than a phenomenon that can be observed chiefly in dead tissue. There is, for example, the almost completely unexplored question of the structure and activities of Golgi bodies in diseased, as compared with living, cells. Also, little is known of the effects of the presence or absence of various hormones, vitamins and combinations of amino- and fatty-acids on the Golgi apparatus in different organs and tissues. Finally, there is the problem of the difference in character and behaviour of the Golgi system in young, as compared with ageing, tissues for all the body organs.

Specific Time of Action of a Gene

R. W. SHOFFNER (*J. Hered.*, 36, 375; 1945) describes a recessive mutation affecting the toes of hens. It is of considerable and general importance since this recessive gene appears only to affect a short period of the chick's life and yet may have a lasting or even a lethal effect. At about one week old the chick, which is homozygous for the gene, develops sclerosed areas in the foot. These at this period do not heal and may lead to loss of toes. If the chick is given care, healing will take place later and the bird will appear normal except for possible lack of toes. Pathological conditions due to ergot, to dermatitis and to lack of vitamins show some similarity to the condition caused by this dactylosis gene. As the author points out, to guard against deleterious genes which only affect the organism for a short period raises more difficulties for the breeder.

Chromosome Numbers in Iris

L. F. RANDOLPH (*Bull. Amer. Iris Soc.*, 95, 37; 1944) provides a comprehensive list of chromosome numbers in the cultivated bearded irises. As well as providing useful information for breeders, it is seen that most of the 420 varieties listed of the modern irises are tetraploids. Before 1910, most of the horticultural varieties were diploid. It is significant that the chromosome number and therefore the potentialities for the breeder cannot be recognized by external characteristics. The tetraploids are usually larger in flower, and of stronger texture of petal, but there are exceptions.

Mutations in Bacteria

M. DEMEREC (*Proc. Nat. Acad. Sci.*, 32, 36; 1946) shows that both ultra-violet radiation and X-rays increase the mutation-rate of the susceptibility to T1. bacteriophage in *Eschericia coli*. The increase in mutation-rate is comparable to that found in higher organisms after irradiation. A most interesting discovery is that the mutation-rate remains high for several generations after irradiation. Various hypotheses to account for this delayed effect are discussed by the author.

Solid Diffusion and Petrogenesis

A DISCUSSION by J. A. W. Bugge of the geological importance of diffusion through solids (*Norske Videnskaps-Akad. Oslo*, 1, 1945, No. 13; 1946) is of great interest in connexion with current investigations of granitization. The driving forces of all diffusion processes are related to differences in the chemical potentials (μ) of the elements concerned, and the variation of μ with composition, external pressure and temperature is given detailed description. From theoretical considerations it is supposed that the rates of migration are greater under the thermodynamic conditions of the deeper zones of the earth's crust than those found in laboratory experiments. It is suggested that the migrations responsible for metasomatism occur partly by ionic diffusion through the

crystal lattices and partly by molecular and/or ionic diffusion through the interstices ('intergranular film' of Wegmann) between the minerals. Large ions, such as O, OH and F, will usually diffuse in the 'film', while small ions, such as Si, Al and Na, may migrate almost as quickly through the crystals themselves. The melting phenomena met with in granitized rocks are ascribed to a preponderance of exothermic reactions and to energy supplied from the depths by the primary diffusing particles. Geological consequences are illustrated by examples (showing increasing distances of diffusion) from the Archæan rocks of southern Norway: (*a*) exsolution processes in felspars and other mix-crystals; (*b*) isomorphous substitution in felspars, etc.; (*c*) reaction zones between minerals, for example, coronas around olivine in hyperites; (*d*) reaction zones between rocks, for example, skarn formation and the development of cordierite-anthophyllite-rocks; and (*e*) metablastic and palingenetic rocks, for example, granites and pegmatites.

Capacitors for Measurement Purposes

A PAPER read before the Institution of Electrical Engineers in London by C. G. Garton deals with the variations of capacitance and loss-angle occurring in precision capacitors used for measurement purposes. The degree of accuracy required in current practice is discussed and compared with the performance of available instruments. It is shown that improvements in stability are required in some cases, and could be achieved. The causes of variation are reviewed with relation to time, humidity, temperature, frequency, voltage and screening, and the properties of materials used in capacitor construction are discussed in the same relation. Special attention is given to the less well-known causes of change in capacitance and loss-angle, and also to experimental difficulties which lead to errors in the measurement of these quantities. In particular, attention is directed in an appendix to an apparently unrealized source of error in loss-angle measurements on samples with a guard ring.

Solar Rotation and Shift Towards the Red Measured in Prominence Spectra

J. EVERSHED has continued measurements of the shifts of the *H* and *K* lines in prominence spectra from April 1935 to March 1939 (*Mon. Not. Roy. Ast. Soc.*, 105, 4, 204; 1945). The auto-collimating spectrograph consists of solid glass prisms of 6-in. aperture (*Mon. Not. Roy. Ast. Soc.*, 95, 504; 1935), and the comparison spectrum is formed by a carbon arc containing traces of calcium, and giving the *H* and *K* lines of approximately the same width and intensity as the prominence lines. Previous measures showed that the prominences gave values of the angular speed of rotation in different zones of latitude greatly in excess of values derived from spectra of the reversing layer, or from the motions of sunspots, and the present results confirm this. The equatorial speed of the reversing layer is 14·5°, according to Adams, and Evershed finds that the speed in the prominences is 16·9°. The general shift of the *H* and *K* lines towards the red in this series of measures exceeds the relativity shift by only 0·0081 A. On comparing the results with previous measures it appears that the rotation values were about 2° a day greater at times of maximum solar activity than they were near the minimum of 1933. There seems to have been a decrease in the general shift from 0·015 A. to 0·009 A. in the period 1926–39, and the general mean of all the measures is 0·012 A., which is 0·004 A. in excess of the relativity shift.

Determination of Pentoses in Nucleotides and Nucleosides

A METHOD developed by Wanda Mejbaum in Prof. Parnas' laboratory in Lwow and published in 1939 (*Z. physiol. Chem.*, 258, 117; 1939) enables determinations to be made of free purines, purin nucleotides and nucleosides in microgram quantities: the method, in the original form or with modifications, is widely used. Miss Mejbaum has investigated the value of this method for other nucleotides, for it was found with a preparation of cozymase and phosphocozymase received from Prof. Otto Warburg that only one pentose was found for two phosphorus atoms. This was interpreted by Parnas ("Hdbk. der Enzymologie", 908; Nord-Weidenhagen, 1940; American photoprint, 1943) as indicating that only one of the mononucleotides in the cozymases is a pentose; this interpretation was wrong. Miss Mejbaum has found (*Biochimia*, Moscow, 10, 359; 1945) that the pentose contained in pyrimidine nucleotides (uridylic acid and cydidylic acid) and nucleosides (uridine) are not determined by her method; they give no coloration with the orcinol-reagent. Dihydrouridine behaves like free pentose or like purin nucleotides. The same holds for the determination of pentoses in nucleic acids, where only about one half of the pentoses is determined, namely, those linked with purines, and not those linked to pyrimidines. The same applies probably to the nicotinic part of the cozymases.

Determination of Fluorides in Water

THE importance of the fluoride content of a drinking water in relation to the production of mottled teeth is well known, and methods for the determination of small amounts of fluoride in water are thus important. O. J. Walker and G. C. Gainer (*Canad. J. Res.*, 23B, 275; 1945) describe a method using a photo-electric colorimeter. It is based on the bleaching of the lake from a zirconyl salt and sodium alizarin sulphonate by the fluoride ion. The photo-electric colorimeter is direct reading, the light passing through a long vertical absorption cell, and the apparatus is calibrated with solutions containing known amounts in parts per million of fluoride. The method is not suitable when more than 1·5 parts per million of fluoride is present, and in such cases dilution is necessary.

Oxides of Lead

SOME years ago, LeBlanc and Eberius reported that in the decomposition of lead dioxide, PbO_2, a range of homogeneous oxides of non-stoichiometric formulæ was formed. A. Byström (*Arkiv. f. Kemi, Min. Geol.*, 20, No. 11; 1945) has made a careful X-ray study of the system and has shown that the oxygen content of PbO_2 cannot be below $PbO_{1·95}$, that it gives on decomposition an oxide α–PbO_x which has a range of homogeneity close to the formulæ Pb_3O_5 and Pb_2O_3, and β–PbO_x with a composition very close to Pb_2O_3 and probably no range of homogeneity; and that the range of homogeneity of Pb_3O_4 is very narrow. The modifications of PbO have no or very narrow ranges of homogeneity. The cell dimensions of all the compounds were determined. It appears that the oxides of lead do not present an example of non-stoichiometric compounds, and more careful investigations of other systems would probably diminish further the examples quoted.

AGEING IN MAN AND OTHER ANIMALS

ON July 16 at the Imperial College of Science and Technology, London, a conference was held by the British Branch of the Club for Research on Ageing. Delegates of European branches of the Club and some other guests interested in the subject were also present. Lord Nuffield was elected honorary president of the conference, and Sir Francis Fraser, chairman of the conference.

Sir Francis Fraser introduced the delegates from other countries. He then proceeded to describe the role of clinical research on old age. Clinical research is the most difficult of all fields of research as there are always so many uncontrolled factors to consider. Quick results are not to be expected; one must think in terms of long-continued and laborious research. Pathological conditions are generally present in addition to old age, and it is difficult to differentiate between them. He concluded that clinical research on physiological ageing is practically impossible, and that it is better for clinicians to concentrate on studying primarily the pathological conditions.

Prof. F. A. E. Crew gave an account of recent work in Scotland on the sociological problems of an ageing population. The current figures for births, deaths and marriages appear satisfactory on the surface, but when looked into more carefully the present population trend shows a most disquieting increase in the proportion older than sixty-five. Since industrial capacity diminishes after the age of thirty-five there is a danger of the old becoming a burden on the younger members of the community. He went on to analyse the statistical figures of the causes of death, and he urged the need for closer collaboration between clinical investigators and those working on population research. The real problem of gerontology is "not how to give years to life, but life to years".

Dr. M. Critchley urged the need for further research on the nervous system in the study of normal ageing as well as the associated pathological conditions. He outlined in detail a number of possible schemes of research of importance for neuro-gerontology.

Dr. V. Korenchevsky expressed the aim of gerontology as not merely to achieve a longer life, but a stronger one. Since ageing starts at a very early age, we must include the study of the whole life-span and even the development of the fœtus. Attempts that had been made at rejuvenation by such methods as Voronoff's glandular grafts, treatment with hormones or Bogomolets' serum, have proved unsatisfactory, since they achieve only a temporary stimulation: the aim must be to discover and remove the causes of premature ageing and not merely to stimulate degenerated tissues. He outlined five conditions required for international and local organisation, if research on ageing is to progress at a reasonable rate.

Prof. F. C. Bartlett believed that the effects of ageing on psychological performance can be compared with the effects of other factors such as extremes of heat, humidity and noise. Each of these factors produces an increased liability to fatigue, which can be measured in a number of ways. New methods developed for the study of skill and fatigue in air pilots during the War may be applicable.

In the discussion which followed these papers, Prof. G. R. Cameron emphasized the need for quantitative research on the effects of ageing on the blood vessels of the brain: there is scope for the employment of many new techniques on this problem. Lord Nuffield said he could not understand how ageing could begin in early childhood, since the athletic performance of a child goes on improving up to the age of fifteen. Dr. Korenchevsky and Dr. J. Hammond pointed out in reply that different organs develop at different ages: brain and bone have priority at an early age, and muscle develops only later. Prof. M. J. Stewart would like research to be carried out on changes in the blood in old age: it is a striking fact that many old people die of pneumonia because their blood fails to respond as vigorously as that of young people to the toxins of the pneumococcus. Dr. D. Richter urged the need for more accurate statistics of the causation of death. The present figures are unreliable, as permission for a post-mortem is often refused. The public must be educated into a realization of the importance and value of post-mortem examinations. The development of gerontology as a science can be seen in the two editions of Cowdry's book on ageing. The first edition was made up largely of speculation and poetry: the second edition contained less poetry, but more facts, figures, tables and measurements. Clinical science can help in the same direction by obtaining greater precision in defining and measuring the factors concerned. Dr. L. Fairfield deplored the way in which the chronic sick and aged are despised by the teaching hospitals and thrust on the public authorities. Medical science has relieved many of the worst miseries of old age, such as the bladder and prostate troubles; but senile dementia is a social problem of increasing urgency. Is it right that healthy young women, who should be bringing up children in their own homes, are now engaged in washing the dirty linen in wards of senile dements?

The guests from Sweden, Denmark, Holland and France then reviewed the work on ageing that is in progress in their respective countries. Dr. B. Purchase, who gave the point of view of a coroner, agreed as to the unreliability of the present statistics, and said he could provide reliable figures for some two thousand cases a year on which post-mortems have been carried out. Prof. Crew said he is anxious to close with Dr. Purchase's offer, as he has been trying to obtain experimental material of this kind. Dr. Fairfield considers that the apparent conspiracy among general practitioners to avoid putting cancer on death certificates might be sufficient to make a significant error in the figures.

The morning session was closed by the passing of five resolutions proposed by Dr. Korenchevsky and expressing the views of the conference as to the requirements for the further rapid advance of gerontology. These included international co-operation between those interested in the subject (for which purpose the Club was founded), establishment of permanent institutes for research on ageing and the provision of ample funds necessary to secure these facilities.

At the afternoon session Dr. P. C. Williams read a paper for Prof. E. C. Dodds on the significance of androgen and œstrogen excretion in the urine in relation to ageing. The tendency to cancer of the prostate is considerably affected by the sex hormone balance, as shown by experiments on castration and by the effects of administering stilbœstrol in the male. There is a need for further quantitative data on all age groups.

Prof. Crew pointed out that the male infant has a

much poorer chance of survival than the female. A male infant with broncho-pneumonia is thus suffering from two conditions: (a) broncho-pneumonia and (b) maleness. Could we use sex hormone preparations to effect a temporary transformation of a male infant into a female to get over this disadvantage?

Dr. Hammond described recent work at Cambridge on the ageing of the fœtus in rabbits and sheep. The chronological age must be differentiated from the physiological age, as measured by the size, the ossification of the bones and development of the heat-regulating centres. The physiological ageing of the fœtus can be varied experimentally by controlling the size of the litter and the nutrition of the mother. He suggested that similar factors may operate in the return to an infantile condition in old age.

Prof. J. B. Duguid put forward a new theory of the thickening of the arteries in atherosclerosis. He believes that we have been misled by the teachings of the Virchows. The thickening does not come from within the artery walls: it is due to the organisation of successive layers of fibrin deposited on the intima. The difference is fundamental, since in his view the primary cause of the disease is in the blood rather than in the vessels. Prof. Cameron asked how this view could account for lipoids in atheromatous plaques. If the arterial narrowing is due to encrustation with fibrin from without, why do not the veins get narrowed in the same way? Prof. Duguid replied that the relation of lipoid changes to atheroma is not fully understood. The veins do not get narrowed, because when they are thrombosed the whole vein becomes blocked, while in an artery, the vessel is cleared by the rapid flow of the blood.

Dr. Korenchevsky gave an account of experiments on the artificial premature 'climacteric' and its effects on the process of ageing in female rats, and the influence on this process of androgenic, œstrogenic and thyroid hormones. Ovariectomy hastens the ageing of rats. The combination of androgenic, œstrogenic and thyroid hormones together produces an apparent 'anti-ageing' effect, as judged by the organ weights and histological appearances of some vital organs; but this may be merely a temporary stimulation of ageing organs. Prolonged treatment may be followed by collapse, since the stimulants do not remove the causes of ageing.

Dr. W. Stephenson read a paper for Dr. P. E. Vernon on the psychological conclusions from an investigation of the effects of vitamins on senile patients at Tooting Bec Hospital. It was concluded that large amounts of vitamins exert little effect on psychological ageing, when the diet is adequate in these compounds. Dr. Stephenson described also some work of his own in which an increased amount of vitamins in a diet previously deficient in these substances was followed by an improvement in the mental capacity of senile subjects. Prof. Bartlett criticized the use of psychometric tests in these experiments, as he holds that the performance of such a test is not characteristic of senile subjects. It would be better to measure the kind of things that old people normally enjoy doing.

Dr. Richter described an investigation on the biochemical changes in ageing. The results indicate that the mental and physical deterioration in ageing are different processes that can be defined by their biochemical accompaniments. Biochemical changes are found in the blood in advanced physical senility which are distinct from the changes normally occurring in old age: the changes associated with senile dementia are different again. Senility is not a simple entity, but is made up of a series of pathological processes, which should be more clearly defined by further work. Our ignorance of the biochemical changes in the tissues in ageing is a big gap in our knowledge. Much public money is now being spent on palliative measures in providing homes for old people: there is an urgent need that more should be spent on preventive measures, which means research.

Dr. J. H. Smyly gave an account of the methods developed by him for assessing physical fitness in old men. These included exercise tolerance tests as measured by pulse-rate and oxygen consumption. The usual methods may be dangerous for old people.

Prof. Crew, in summing up, said that the proportion of old people in the population is increasing, and gerontology is therefore a science of increasing social importance. Geriatrics must also come to occupy a part not less important in medicine than pediatrics to-day. He recommended the formation of a permanent international congress committee to organise international gerontological congresses.

MIMETIC POLYMORPHISM

By Prof. G. D. HALE CARPENTER, M.B.E.
University Museum, Oxford

DR. RICHARD B. GOLDSCHMIDT has discussed the origin of mimicry in a paper entitled "Mimetic Polymorphism, a Controversial Chapter of Darwinism" (*Quart. Rev. Biol.*, **20**; June and Sept., 1945). As he rightly says, most field naturalists accept the facts of mimicry. He returns to the theory of production of a mimetic resemblance by saltations, but the discussion, being mainly on the genetical basis, ignores the fact that mimicry is essentially a phenomenon of life, and that far-reaching conclusions drawn from the study of the colour and pattern of a few dried butterflies do not cope with a vast number of cases among other creatures. Indeed, he remarks that in view of conflicting evidence as to habits, etc., of mimetic butterflies, it is better to mark this group of doubtful adaptations as *non liquet*. Were Goldschmidt more familiar with at least the records of field entomology, he would have found very many observations from naturalists of experience who have been deceived against their better judgment. The resemblance of an ant-like spider to its model is notorious for the part played by special movements and attitude, both foreign to the generality of spiders. The deceptive resemblance of longicorn beetles to Hymenopterous models (Braconidæ) is so great that experienced collectors have recorded their inability to distinguish them in flight. A black fossorial wasp in tropical America has the habit, while very actively running about on the ground, of vigorously flicking its wings. This characteristic is copied by two other insects far removed in relationship, a Reduviid (Hemiptera) and a Tettigoniid grasshopper which, agreeing in their wholly black coloration with the wasp, have the same habit, completely foreign to their congeners. Quite recently I was told by a leading Brazilian naturalist of how he was warned by an entomological companion not to touch a certain black insect as it stung very badly: the insect was the mimetic grasshopper.

The fact that mimicry sometimes does not deceive is of little importance beside the fact that sometimes

it does. The natural enemies of insects are not studying the patterns of dead specimens in a cabinet, at leisure. In the field, if a hunter, in the midst of the abundant life of the tropics where mimicry flourishes, hesitates over a doubtful specimen and turns to one of unequivocal appearance, the doubtful one escapes with its life.

Every field naturalist has been momentarily deceived by an insect which seemed other than what it really was. An experienced student and collector of British butterflies told me that every year when the 'wall' butterfly (*Dira megera* L.) appears he is occasionally puzzled by a specimen which, for a moment, seemed to be something else. The difficulty of 'the first step' is much less of a difficulty to a naturalist than to a geneticist. The following incident is illuminating. When in Africa I had a young monkey which one day played around as I sat on a chair mending some clothes; suddenly the monkey made the warning noise for 'snake'. Puzzled at first, I eventually found out, when he repeated the warning, that he was afraid of the thimble on my finger, and would not come near it. Apparently the bright surface, pitted, and the shape, evoked the response to a snake. Had this appearance been on the anterior extremity of a Sphingid or other large caterpillar among leaves, suddenly seen for a moment, one cannot doubt that the caterpillar would probably have been left alone. This would have been an early step in the production of snake-mimicry.

Goldschmidt says that the decisive part of the mimicry under consideration is the wing-pattern. But this does not mean that wing-pattern is the whole of mimicry. Exception must be taken to the statement that for a discussion of this topic we ought to distinguish between different types of mimicry. By this the critic does not mean between Batesian and Mullerian resemblances, but between resemblance to a dead leaf and resemblance to another living animal. I see no necessity for supposing that these two cases are differently produced; indeed, they grade into one another so that a definite line between them is impossible.

Ant-like spiders have already been mentioned. But Hingston described a spider which, found on the rubbish-heap outside the entrance to an ant's nest, when alarmed tucked its limbs beneath the body and closely resembled a common object on such a rubbish-heap, namely, the chitinous skeleton of the head of a dead ant. Is resemblance to part of a dead ant to be sharply separated from resemblance to a whole, living ant? To a Darwinian, one is an example of special procrypsis, while the other is pseudaposematic; both are cases of resemblance to some object of little or no food value.

Another general point calls for comment. Goldschmidt classes Mantids among the predators which, at least, sustain mimetic resemblance. But that is not the view of supporters of the Darwinian theory which he is combating. It is known that not only do predacious arthropods devour 'warningly coloured' prey but also that in some cases they show preference for it. In general, mimicry is not directed against predacious arthropods, though it is possible that the resemblance of spiders to ants is such a case. Arachnologists have stated that hunting spiders are extremely important enemies of other spiders, and that spiders are usually afraid of ants. The quick, ant-like movements of mimetic spiders, which live among ants, have in some tests been shown to be protective against attack by other spiders.

Much use is made of parallel mutation to explain the cases of mimicry which are mentioned by Goldschmidt. It is stated that widely different models of different mimetic females of a species are related among themselves. The case of *Papilio dardanus* at once comes to mind; while Danaidæ serve as models for most of the female forms, a species of Acræidæ is the model for another. If we consider different members of a genus we often find widely different models. In the butterfly genus *Euphœdra*, two species mimic Agaristidæ, another an *Aletis*, these being day-flying moths widely separated from each other and from the mimics. The study of geographical distribution provides examples which do not seem to tally with the facile explanation by parallel mutation. *Acræa johnstoni* Godm. resembles, in most of its forms, Danaid models: it is widespread throughout less densely forested parts of Africa. In the mountainous country of western Uganda it occurs in only one form, mimicking, not a Danaid, but the Acræid *Bematistes* (=*Planema*) *quadricolor* Rogenhofer, a species with very unusual and peculiar purplish-brown colouring, which is found again, hundreds of miles to the east, on the mountains of Kenya and Tanganyika Territory. *Acræa johnstoni*, however, on the eastern mountains, does not mimic the *Bematistes*, but, as in all the intervening country, mimics the predominant Danaids of its locality. Danaid models occur in western Uganda, but there is no parallelism between them and the *Acræa*.

Again, *Papilio cynorta* F. has a female always different from its male. In West Africa it is mimetic of the black and white female of *Bematistes epæa* Cr., the male of which has the white replaced by orange-brown. In Abyssinia both sexes of the *Bematistes* are like the western male, but the female *P. cynorta* does not agree with this and resembles the black and white local race of the Danaid, *Amauris niavius* L., which occurs abundantly also in West Africa. It may be asked how does parallel mutation serve as an explanation of cases in which there is mimicry on the *upper* surface of the wings but another appearance on the *under* surface? Thus, in the Oriental and Ethiopian regions, species of Danainæ and Euplœinæ are mimicked by Elymniinæ on the upper surface, which are cryptically coloured below. The South American Nymphaline *Protogonius* are very like dead leaves on the under surface, but above they mimic the prevailing type of Ithomiine coloration. Some African Papilionidæ resemble spotted Danaines above but have a warning colour of their own, entirely different, on the under surface. The remarkable African Lycænidæ of genus *Telipna* are like species of *Acræa* above, but have a characteristic warning coloration of their own beneath.

A general point that does not seem to have struck critics may be thus stated. It is surely very strange that parallel mutation seems to concern itself with producing only conspicuous coloration. Why does it not produce similarly deceitful resemblances among *cryptic* species? Innumerable butterflies and moths resemble dead leaves, but although they resemble the same things (syncrypsis), they do not resemble each other, as mimics resemble models.

All the arguments from parallel mutation are concerned with colour and pattern in butterflies only. The mimicry of the Australian wasp *Abispa ephippium* F., red-brown with a transverse black abdominal band, by two similarly coloured longicorn beetles is most instructive. One, *Tragocerus formosus* Pascoe,

has the normal elytra with the black band across them. As they are kept closed over the abdomen in flight, in this species, the resemblance to the wasp is the same whether the beetle flies or is at rest. The second beetle, *Esthesis ferrugineus* Macleay, has extremely truncated elytra which do not reach the position of the black abdominal band in the wasp. The black band is, in this beetle, across the abdomen itself. So, in this set of examples, the black band is placed on the abdomen in the wasp and one mimic, on a thoracic appendage in the other mimic. The effect is the same, however. This is only one example of the production of the same effect by different means, a phenomenon treated very lightly by Goldschmidt, rather as an inconvenience. Arguments about mimicry based on the statement that the pattern systems of different families of butterflies are in reality not very different are useless for dealing with a wider aspect of mimicry.

Goldschmidt quotes with approval Punnett's statement that cases of mimicry tend to run in series; for example, the African Papilionid species of *Graphium* tend to resemble Danaidæ and Acræidæ. But, it may be asked, What else is there for them to mimic? For this argument to be valid, it would have to be shown that there also exists in Africa a group of conspicuous distasteful butterflies (such as *Euplœa* in the East) which are *not* mimicked because the parallelism between Papilionidæ, Danaidæ, and Acræidæ keeps the former to these models. It may be confidently stated that should Euplœas find their way to Africa, they would be mimicked.

Finally, exception must be taken to a statement made by Goldschmidt in his discussion of seasonal dimorphism, which is compared with mimicry. He says "The mutant must be such as to affect the primary patterning processes, it can change the pattern thoroughly because the proper developmental system is already available", and then continues (the italics are mine) "Small wonder therefore that *mimetism is about as rare as extreme seasonal dimorphism*, and that it is *confined to a few nearly related members of a few systematic groups*". This most extraordinary statement is presumably due to lack of knowledge, for a glance through such a work as Seitz's "Macrolepidoptera of the World" would have dispelled the illusion. Particularly in the case of the tropical American butterflies is the statement untrue, for in the great humid forests there can be little seasonal change of appearance. I have some experience of African species, and have used volume 13 of Seitz's work on the African Rhopalocera. In order not to seem biased, I have taken none of the examples of mimicry of *Mylothris* by other Pierids as being nearly related, and none of the rather elementary cases of mimicry to be found among forest Nymphalines. I have also omitted resemblances of *Acræa* to their larger relatives *Bematistes*, and resemblances among species of the genus *Charaxes* to each other. On the other hand, the comparatively slight seasonal differences in Satyrinæ have been discounted.

The cases of "extreme seasonal dimorphism" in Africa comprise *Charaxes zoolina* Westw. and six species of *Precis*: total, seven. Against these can be set the following very definite cases of mimicry by *species*. Papilionidæ, 10; Satyridæ (Elymniinæ), possibly all one species, 1; *Euxanthes* and *Charaxes*, 5; various Nymphalines, 7; *Pseudacræa*, 8 species, of which one, *eurytus*, has a great number of forms; *Hypolimnas*, 5. Among Lycænidæ, one can easily find 40 mimetic species, and a few Hesperiidæ are known with Acræoid under-sides.

The other statement, that mimetism is confined to a few nearly related members of a few systematic groups, is almost as untrue, and becomes quite ridiculous if a little wider view of the subject is taken: the enormous, complex association of mimics of Lycid beetles at once calls for consideration.

THE BRITISH INSTITUTE OF PHILOSOPHY

On April 6 of this year the British Institute of Philosophy (University Hall, 14 Gordon Square, London, W.C.1) completed the first twenty-one years of its existence. The occasion was marked by a letter to *The Times* from Lord Samuel, president, Sir David Ross, chairman, and Lord Lindsay, vice-chairman of the Institute. A leading article in the same issue, "The Sovereign Mind", dealing with the work of the Institute, stressed the need for the pursuit of abstract truth and the scrutiny of ideas offered to the people as springs of action. Founded "to serve as a link between philosophers and the everyday world", the Institute has fulfilled this aim in many ways. It has organised courses of philosophical lectures as well as popular addresses in London. It has founded branches in Bangor, Cardiff, Liverpool, Manchester, Newcastle and Durham, and Sheffield under the auspices of the Universities in those centres, and usually under the direct guidance of the head or some member of their departments of philosophy giving his services free. Its journal *Philosophy*, which ranks with professional journals in philosophy and draws contributions from the leading philosophers in Britain, has performed the feat of compelling philosophers to write so as to be understood by laymen, and has achieved as a result the unique distinction of being read with enjoyment and profit by laymen and philosophers alike. All this has been done with a membership of only a little more than a thousand.

At the reception held on July 23 to celebrate the Institute's coming of age, Lord Samuel was able to announce a fifty per cent increase in membership as a result of the anniversary appeal. The reception was followed by addresses on "The Need for Moral and Intellectual Leadership" by Lord Samuel, Prof. A. V. Hill, Canon Hodgson and Prof. E. R. Dodds. Lord Samuel saw the ultimate sovereignty as residing not in governments but in the people, and the people as needing the leadership of ideas. Such ideas would have to come from religion, science or philosophy, three ways of thought that have frequently beckoned in different directions. He deplored the small influence philosophy commands in the world to-day, due to its absorption in scholastic disputes and its alleged rule of method: 'Take no hair and split it', and recalled it to its traditional task—to interpret the human situation.

Prof. Hill saw the question as a problem of finding in a democracy men who combine reasoned ideas with the power of persuading people to adopt them. Science is not enough. The Hippocratic oath is as important as the Hippocratic method: and the necessary and rightful exclusion of moral considerations from the weighing of scientific truth should not be allowed to result in the extrusion of moral values as irrelevant to the wider situation in which the

pursuit of truth is one value among others and commands the devotion of men.

Canon Hodgson spoke of the creeds, or philosophies of life, by which men live, as needing to be at once rational and empirical. The Christian faith has its empirical side, as matter for theology; its rational side, as matter for philosophical criticism. It must hold fast to one, if it is to benefit from the other.

Prof. Dodds focused more narrowly upon the universities as the growing points of an educated democracy. Leadership must carry no suggestion of indoctrination. To train men with an educated intellectual conscience is the function of the universities, which are the very model of the 'open society'.

Prof. Dodds would presumably welcome the disorder in our beliefs to-day as at least a sign of the right of the individual conscience. Yet there may be some middle path. What we have to-day is not divergence within a pattern but divergence of patterns. The intellectual conscience is a fine conception, but it is only one side of man, who cannot be thus dissevered. It is man as indissolubly rational and moral that is the final test of all theories. Some theories are ruled out by this test; but experimentation must go on, because only in this way can they be ruled out. Modern thought has gone too far in proclaiming the irrationality of man, owing to the too narrow conception of reason with which it has operated. As Prof. Hill pointed out in his address, 'reasonable', in English, has a moral as well as an intellectual connotation. On linguistic grounds alone there must be something wrong with a conception of reason which does not do justice to this fact. It is the philosopher's duty to articulate those realms of reason which lie outside science, and it is time for him to take his courage in both hands and set about this task.

The reception was held in the rooms of the Royal Society. The venue was appropriate, if one remembers the wider aims which the founders of the Royal Society had in mind. There must to-day be many men of science who feel the need to discuss the wider philosophical issues of their work, which recent developments have forced into the forefront of the scientific consciousness. Certainly the Institute needs scientific men among its members. In this connexion it is worth noting that its journal has included a large number of philosophical articles by men of science.

It is interesting to compare the breadth of philosophic vision the Institute has shown in its twenty-one years career with the tendency in purely professional philosophy during the same period to contract into a highly specialized study of a narrow range of linguistic problems with the esoteric jargon and parochial pride of the typical sect. While eminent men of science like Jeans and Eddington were being driven into metaphysics by science, some professional philosophers were claiming that a true understanding of scientific inquiry showed that no other kind of inquiry was possible. There are signs that this period, valuable as its results have been, is drawing to a close. The joint session of the Aristotelian Society and the Mind Association, held in Manchester during July 5–7, showed that broader conceptions of philosophy are returning. Unofficial visits by members of the session to the University of Manchester to see the Bush differential analyser and the bust of Samuel Alexander by Epstein revealed an equal reverence for the machine and the metaphysician; and one philosopher was heard saying, as he left a group surrounding the bust, "Never have so many positivists revered such a metaphysician". If these hopes are to be fulfilled, philosophy needs to be fertilized by contact with other subjects. Now that psychology is a grown-up science, it has no longer that close connexion with philosophy which afforded the latter continual stimulus, not to say provocation. A closer contact with all the sciences must take its place. If, as a result, the conception of philosophy as an activity of the sovereign mind—not in any spirit of dominating or controlling other activities of mind but simply as taking a broad and reflective view of the world as a whole—recovers its proper status, no small thanks will be due to the British Institute of Philosophy, whose lamp has burned boldly and brightly when other philosophical lamps were trimmed almost to extinction.

WINSTON H. F. BARNES

PRODUCTION AND ANNIHILATION OF NEGATIVE PROTONS

THE only one known equation to describe particles of spin $\frac{1}{2}$ is that derived by Dirac in his treatment of the electron. It must therefore be employed in any theoretical discussion of nucleons (protons or neutrons), and since Dirac's treatment was able to predict the existence of the positron it is to be expected that anti-nucleons, produced by removing nucleons from negative energy states, also exist.

Experimentally, anti-protons, that is, particles with the mass of a proton but with negative electrical charge, are the more interesting. They have not as yet been observed. The Rev. J. McConnell (*Proc. Roy. Irish Acad.*, A, 50, No. 12, 189; 1945), in a mathematical discussion of the problem of the production and annihilation of negative protons, has shown that the rate of production of such particles is so small that it is not surprising that the negative protons have not been observed in experiments so far perform. With more suitable experimental arrangements, the negative proton could most probably be detected.

Negative protons arise through the formation of nucleon pairs. These pairs could be produced, like electron pairs, from light quanta, but the effect would be extremely small. Alternatively, the pairs could be produced by the collision of cosmic ray mesons with nuclear particles in the atmosphere. The simplest process is that in which two charged mesons collide; and it is shown that if the approximation method due to Dirac is applied to the field, the cross-section for the process increases steadily with the energy—an unreasonable result. It is necessary to make use of the Heitler–Peng theory of radiation damping, and the cross-section for extremely small values of the momentum p is then proportional to p, rapidly reaches its maximum value of $2{\cdot}2 \times 10^{-27}$ cm.^{2} and finally decreases as p^{-6}. The process in which a meson collides with a neutron or proton at rest is also considered. By means of a Lorentz transformation the meson is brought to rest and the nucleon allowed to move, and applying the Weizsäcker–Williams method the field of the moving nucleon is replaced by a field of mesons.

The calculation is admittedly very approximate, but the results are claimed by Mr. McConnell to be of the correct order of magnitude. It is found that pair production does not occur unless the energy of the primary meson is greater than 4×10^9 eV. The cross-section then starts from zero, reaches a maxi-

mum of 7×10^{-29} cm.^{2} at 8×10^9 eV. and afterwards falls slowly to zero. This corresponds to a mean free path of not less than 40 metres in lead.

Neglecting damping, the annihilation of nucleon pairs would, in the Dirac approximation, have the same probability for occurrence as the production, apart from a simple factor arising from the different density functions of the final states, and thus the anti-nucleons on being produced would be immediately annihilated. That this is not so is shown by the further application of the radiation damping theory. It is found that the probability that a high-energy negative proton will be annihilated into mesons on passing through lead is less than 20 per cent, and that on being brought to rest the negative proton is annihilated with emission of light quanta with a mean life-time of about 10^{-4} sec.

Thus, although the negative proton has not yet been observed, the above figures lead to the estimation that for every 1,000 cosmic ray particles observed at sea-level about 0·6 should be negative protons. Williams found that of two thousand particles observed, eight were protons, so that it is to be expected that of the number of detectable protons about 10 per cent are negative protons. It is suggested that experiments on showers of two particles, similar to those of J. G. Wilson (*Nature*, 142, 73; 1938) but with ten times the number of photographs, be performed in order to determine the charge on the particles and to verify the theoretical results.

POPULATION POLICY FOR GREAT BRITAIN

A SERIES of broadsheets issued by Political and Economic Planning during the last few months are of considerable interest in relation to the proposed national health service in Great Britain. The first of them, "Vital Statistics" (No. 241), is concerned with the probable population trends. It points out that although there is scope for further reductions in total mortality, their effect on population growth could only be small compared with last century, when the rapid increase in population was entirely due to the reduction of mortality. Lower fertility within marriage is the main reason why the population has failed to replace itself for the last twenty-four years, and in the long run the declining trend can only be checked by increasing the average number of children per married couple. There are, however, clear signs that it is the deliberate limitation of families by methods of birth control which is mainly responsible for the present decline in fertility. Analysing various possible trends, *Planning* concludes that in no circumstances would it be realistic to expect an expansion of population in England and Wales comparable to that of the last century. The most that can be expected in the long run is a small increase, and this can only be achieved by reversing present trends.

In broadsheet No. 242, "Retreat from Parenthood", *Planning* examines the nature of the human impulses and attitudes responsible for this decline in population, and endeavours to set the most important of these factors in their correct historical perspective. Although there is evidence in all ages of some desire to avoid excessive fertility, there does not appear to have been in Europe any widespread desire severely to limit the size of families until the transformation of life by the industrial revolution was far advanced. Thereafter the growth of financial penalties on parenthood as well as the state of public opinion encouraged the small family pattern. Children to-day are the cause of relative rather than absolute poverty, and limitation of the family is an obvious economy of energy as well as of money. The new awareness of insecurity was a further adverse factor, and the neo-Malthusian movement diffused the idea of family limitation far more widely than it succeeded in spreading actual knowledge of contraception. Again, the enjoyment of leisure, like the attainment of security, is apt to conflict with rearing a family, and the growth of sex equality and sexual knowledge have tended to reduce children from an integral part of the happy marriage to a welcome but not indispensable addition to it, if circumstances make a family appear worth while without too much sacrifice.

The broadsheet concludes by pointing out that the new freedom of parenthood in advanced societies marks the end of the epoch of automatic replacement of human numbers, and the institution of voluntary parenthood obliges society to adopt a population policy. Such a policy must take into account prevailing attitudes to marriage and parenthood, and seek to modify them in socially desirable directions. Simultaneously, it must recognize all the disabilities and obstacles to parenthood, and take action to abate or remove them.

One such line of action is discussed in a subsequent major broadsheet (No. 244. "A Complete Maternity Service"), in which the present condition of maternity services in Great Britain is outlined and the main deficiencies are indicated. Further, a full maternity service is outlined and the proper place of the midwife, the health visitor, the general practitioner, the clinic officer and the hospital are discussed and the functions which the health centre can perform in uniting these individuals in a team. The main, and much the most important, emphasis is laid in *Planning* on team-work and continuity of attention. The second point made in the broadsheet is the development of a more uniform service so that without rigid rules applicable through the whole of Britain for every detail of maternity care, the essential services should be readily available to the woman in a country district as well as to the town dweller and to all income groups. Thirdly, the need of simplifying the administrative structure behind maternity services is stressed. If the target is established and each move is made with that target clearly in view, the achievement of a really marked improvement should not be so difficult as it appears at present, when each section of the services concerned is apt to over-emphasize its importance. Lastly, there is the need for public education. First-rate administration and first-rate services could founder completely on the rock of ignorance or prejudice; the essential facts of the situation must be known and understood by the public for whose comfort and health maternity services are designed

These three broadsheets belong to a series to be embodied in the PEP report on population policies, but the group responsible for this study has found itself unable to deal with the subject satisfactorily without entering on a wider and more difficult inquiry. Population policy must be seen in the context of a democratic society, and belief in the future of society, education in parenthood, and a higher valuation of parenthood by society are three vital factors making for a sound population policy.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DIRECTOR—The Secretary, British Pottery Research Association, Federation House, Stoke-on-Trent (August 31).

ASSISTANT LECTURER (temporary) IN BOTANY—The Registrar, The University, Sheffield (August 31).

ASSISTANT LECTURER IN THE AGRICULTURAL BOTANY DEPARTMENT—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (August 31).

ZOOLOGISTS to sail in whaling factory ships during the Antarctic season of 1946–47—The Director of Research, Discovery Committee, 52 Queen Anne's Chambers, London, S.W.1 (August 31).

LECTURER IN ELECTRICAL ENGINEERING at the Municipal Technical College and School of Art—The Director of Education, Education Offices, Library Street, Blackburn (August 31).

BIOCHEMIST in the Ministry of Health Area Laboratory—The Medical Superintendent, City Hospital, Hucknall Road, Nottingham (September 1).

PROFESSOR OF STRUCTURAL ENGINEERING AND FOUNDATIONS, an ASSISTANT PROFESSOR OF ELECTRICAL TESTING AND MEASURING INSTRUMENTS, an ASSISTANT PROFESSOR OF IRRIGATION AND IRRIGATION DESIGN, and a PROFESSOR OF GEOLOGY, at the Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 3).

ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (September 6).

ASSISTANT LECTURER (or LECTURER) IN CHEMISTRY, and an ASSISTANT LECTURER IN PHYSICS—The Registrar, University College, Southampton (September 7).

AGRICULTURAL ASSISTANT, and a HORTICULTURAL ASSISTANT—The Chief Education Officer, Shire Hall, Cambridge (September 7).

PRINCIPAL OF THE BARNSLEY MINING AND TECHNICAL COLLEGE—The Director of Education, Education Office, Town Hall, Barnsley (September 7).

HEAD OF THE CHEMISTRY DEPARTMENT—The Principal, Municipal Technical College, Hopwood Lane, Halifax (September 9).

SENIOR ENGINEER, an ENGINEER, and an ASSISTANT ENGINEER, in the Television Section, Research Department of the B.B.C.—Engineering Establishment Officer, Broadcasting House, London, W.1 (September 9).

PRINCIPAL OF THE COVENTRY TECHNICAL COLLEGE—The Director of Education, Council House, Coventry (September 14).

LECTURER (Grade III) IN THE DEPARTMENT OF GEOGRAPHY—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (September 14).

LECTURER IN MATHEMATICS in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 15).

DIRECTOR OF RESEARCH—The Secretary, Federation of Dyers and Cleaners, 7 Laurence Pountney Hill, Cannon Street, London, E.C.4 (September 21).

LECTURERS (2) IN ZOOLOGY (one to assist in the teaching of Vertebrate Zoology, the other of Invertebrate Zoology), and a MUSEUM ASSISTANT (experienced)—The Secretary to the University, Old College, Edinburgh 8 (September 25).

DEPUTY PUBLIC ANALYST in the Public Health Department—The Town Clerk, Town Hall, Manchester 2, endorsed 'Deputy Public Analyst' (September 28).

MEDICAL GRADUATE as Assistant to the Director—The Director, Wellcome Museum of Medical Science, 183–193 Euston Road, London, N.W.1 (October 1).

LECTURER IN BIOCHEMISTRY—The Secretary, Queen's University, Belfast (October 5).

LECTURER IN PHARMACOLOGY, and a RESEARCH ASSISTANT IN THERAPEUTICS—The Registrar, The University, Sheffield (October 14).

LIVESEY CHAIR OF COAL GAS AND FUEL INDUSTRIES—The Registrar, The University, Leeds 2 (October 15).

CHAIR OF CHEMICAL ENGINEERING—The Registrar, The University, Sydney (December 31).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne.

LECTURER IN THE SCHOOL OF PHYSICS AND APPLIED SCIENCE, a LECTURER IN MATHEMATICS, and a LECTURER IN MATHEMATICS and PHYSICS—The Principal, Leicester College of Technology and Commerce, Leicester.

RESEARCH ASSISTANT to the Professor of Physiology—The Secretary, Medical School, Middlesex Hospital, London, W.1.

LECTURERS IN MATHEMATICS, APPLIED MECHANICS (2), and PHYSICS, at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, London, S.W.1.

GRADUATES of Universities of recognized standing in the fields of Electrical Precision Measurements, General Physics, Metrology, Heat, Acoustics, Atomic Physics, Electrical Engineering, Radio, Optics, Radiology—The Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Canada.

TEACHER (full-time) IN THE ENGINEERING DEPARTMENT to take the following Higher National Certificate subjects: Metrology, Machine Shop Technology, Workshop Technology and Workshop Practice—The Principal, Stockport College for Further Education, Stockport.

LECTURER IN AGRICULTURE—The Secretary and Registrar, University College of North Wales, Bangor.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

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Tin Research Institute, 1942–1944: a Report of the Work of the Institute, its Current Researches and their Bearing on Future Developments. Pp. 32. (Greenford: Tin Research Institute, 1945.) [193

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1939, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xviii+40. Results of Geophysical and Solar Observations, 1940, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xviii+40. Results of Geophysical and Solar Observations, 1941, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xvi+40. Results of Geophysical and Solar Observations, 1942, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xiv+40. Results of Geophysical and Solar Observations, 1943, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xv+40. (Blackburn: Stonyhurst College Observatory, 1939–1943). [193

National Physical Laboratory. Tests on Volumetric Glassware. Pp. 38. (Teddington: National Physical Laboratory, 1946.) Free. [193

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Annual Report on the Progress of Rubber Technology. (Published for the Institution of the Rubber Industry.) Vol. 8, 1944. Edited by Dr. T. J. Drakeley. Pp. vi+139+xi. (Cambridge: W. Heffer and Sons, Ltd., 1946.) 4*s*. 6*d*. net. [253

Ministry of Health. National Health Service Bill: Summary of the proposed New Service. (Cmd. 6761.) Pp. 18. (London: H.M. Stationery Office, 1946.) 3*d*. net. [253

Technical Aspects of Housing. By H. Rose. Pp. 16. (London: Association of Scientific Workers, 1946.) 6*d*. [283

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Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ended June 30, 1944. (Publication 3776.) Pp. ix + 503 + 40 plates. (Washington, D.C.: Government Printing Office, 1945.) 1.50 dollars. [112

Indian Central Jute Committee. Technological Research Memoir No. 7: Measurement of Important Physical Characters of Jute Fibre Strands and their relation to Yarn Quality. By Dr. K. R. Sen and C. R. Nodder. Pp. 20. (Calcutta: Indian Central Jute Committee, 1944.) 14 annas; 1*s*. 3*d*. [112

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INFORMATION SERVICES AND SOCIAL SURVEY

IN the debates and discussions regarding the termination of the Ministry of Information, either in Parliament or elsewhere, there has been little recognition of the importance of information services in a democratic government, both from the point of view of keeping the Government informed of the state of public opinion, and of keeping the public adequately informed on the many matters in which government action impinges directly on their daily lives. The Prime Minister has indeed admitted that such services have a permanent place in the machinery of government, but there can be no doubt that had this point received more attention in framing and executing policy, much of the friction and opposition engendered by the restrictive measures introduced by the Government might have been avoided. It will be remembered that in one of its reports the Select Committee on National Expenditure, recording its view that the War-time Social Survey of the Ministry of Information was an essential service, recommended that the Survey should be used for factual inquiries which are necessary to guide a Ministry in some particular policy, and that the Survey itself should be placed under the authority of the Lord President of the Council rather than of the Ministry of Information.

It has in fact become, as a P E P broadsheet observes, "absolutely vital that the state and all organisations whose business it is to serve or control the public should have an accurate knowledge of the ways of thought and action and of the environment of the people for whom laws or service are intended". The social survey is one instrument still in the early stages of development by which this vital social information can be obtained, to assist—but not to relieve—the administrator in his responsibility for wise judgment in the interests of the nation and for providing leadership. According to the Prime Minister's statement on March 7, the Central Office of Information is to be placed, with the machinery of integrating and co-ordinating departmental information policy and action, under the general supervision of the Lord President of the Council, and the Civil Estimates for 1946–47 include, in a vote of £2,631,300 for the Central Office of Information, £63,000 for the Social Survey.

The broadsheet already mentioned (No. 250, "The Social Use of Sample Surveys") contributes much more than a valuable analysis of the work of the Social Survey: it discusses the need for co-ordination and for establishing recognized standards of technique, which would avoid the wastage of valuable social data and also the initiation of overlapping, unnecessary or amateurish surveys. Primarily, the broadsheet is concerned with surveys of social habits and environment, although the survey of opinion is not altogether neglected. It points out that the state of public opinion is one piece of evidence to be considered in framing policy, and not necessarily the most weighty element, as indeed the food situation in Great Britain

illustrates. If, however, surveys of opinion are to become a feature of normal democratic machinery, it will be necessary to watch closely for what purposes these surveys are used, and to relate this practice to the general philosophy of British democracy, which has normally rejected the plebiscite or referendum as a piece of constitutional machinery.

Since the Select Committee on National Expenditure reported in February 1942, the survey method has become a social research unit the services of which are regularly used by many departments, and *Planning*, in assessing the significance of survey methods, emphasizes the danger of excessive claims. A social survey is defined as an objective and unbiased investigation of habits, environment or views of a group of people. As such it can never replace censuses, although in practice its beginning can be seen in the work of Defoe, Cobbett, Howard and Chadwick, long before Charles Booth's "Life and Labour of the People of London". It should be noted, too, that well-informed critics are rarely concerned with errors which might arise in surveys solely because of the use of sampling, provided the sampling and analysis is well done.

The P E P broadsheet gives an admirably concise review of the surveys already conducted in Britain before discussing the scope of sample surveys, the objections usually advanced against them and the technique employed. It is from this lucid assembly of facts establishing beyond question that the social survey is an essential tool in social policy and in government policy that *Planning* proceeds to consider future public policy on surveys.

While it does not follow of necessity that a social survey unit should be maintained as part of the government machine in Britain, there are strong arguments in favour of this course. Government demands are likely to be considerable in view of the extensive programme of social and economic reform which faces us; and it is unlikely that a university or a commercial organisation or any other outside body will always be ready to undertake a suitable project on behalf of the Government when such work is needed. Moreover, experience as well as money is wasted if staff has to be collected for each survey and is dispersed again when the particular work is completed. Accordingly, P E P recommends first that a survey unit for carrying out social survey work on behalf of the Government should be retained and attached to the machinery of government, possibly to the Central Office of Information, particularly as the connexion of that body with the Lord President's office, which is concerned with scientific research rather than administration, will now emphasize a scientific approach to survey work. With this, however, is needed co-ordination of government statistical work, both in the field of sample survey and in work such as that of the Central Statistical Office and the forthcoming censuses of production and distribution. Common use of the expensive calculating and card-punching machinery should also be arranged.

According to P E P, however, there is no reason for insisting that all government work should be carried out through such a Government survey unit. Commercial organisations or universities may sometimes have specialized experience which will be of particular value for special work. Some form of competition will provide a healthy stimulus to both sides, and occasionally when two or more surveys may be required by the Government simultaneously, additional help may be needed. Again, an individual department may on occasion be able to give valid reasons for carrying out a particular survey with its own staff. For such reasons, while the Government would naturally keep its own survey unit fully occupied, it should have complete freedom to initiate survey work through any selected organisation.

The Government survey unit itself should not, in the opinion of P E P, be confined to special surveys undertaken for particular legislative or administrative purposes. It should be able to initiate more general research, for example, on problems of sampling, long-term trends in migration, changes in the circumstances and habits of various social groups. Some of this work can, of course, be undertaken already by universities and other bodies; but there are fields in which research is badly needed but which cannot be tackled owing to the expense involved and the lack of any immediate commercial consumer for the information which might be obtained. In these fields the Government unit could very clearly make a contribution in the public interest, but P E P is undoubtedly right in urging that it is desirable that such basic research should be undertaken only if the academic and other organisations in the same field agree as to the necessity for the work to be done.

Full consultation should come first, and accordingly the broadsheet suggests that some machinery for consultation should be provided. Its second recommendation is in fact that the Government should initiate conversations with the universities, scientific and social institutions, commercial organisations and others concerned in the field of social survey to consider what action should be taken, whether by the creation of an institution or otherwise. Since, however, many local authorities are anxious to undertake surveys in connexion with their housing and other plans in the post-war period, while universities and charitable trusts will wish to continue survey work of their own in connexion with particular social and economic studies, some adequate machinery is needed for co-ordinating such efforts, for standardizing technique so far as is advisable, and for probing and analysing the results of independent research work. Moreover, some of the research on consumption carried out by commercial organisations may overlap with surveys of this type and could yield more valuable results if correlated so far as units of measurement or definitions, for example.

In addition to providing a source of competent, professional advice on the planning and execution of social surveys, particularly for local authorities and similar bodies intending to undertake a survey, the broadsheet suggests that such a central institution could maintain a register of all projects for sample surveys, by the Government, the universities or commercial organisations in order to direct attention t duplication or any links which could easily be pro-

vided, as well as to collect and collate the results of at least those surveys which are not necessarily kept confidential for purely commercial reasons In addition to maintaining records of the results of surveys and undertaking a comparative analysis of the results on occasion, a central institution could advise on the framing of questionnaires, the training of interviewers, and the technique of execution and analysis. The broadsheet also suggests that it could promote good standards of work and good relations with the public, and provide a forum for the interchange of information, both as to projects, technique and results, for example, by the publication of a journal reviewing work being carried out in Great Britain and making available details of international work, and by holding annual or other periodic conferences of those engaged in survey work and publishing the proceedings.

While *Planning* advances this list of some of the functions which could be undertaken by a central institution, it does not at this stage recommend that they should all be undertaken immediately, or that they should all be undertaken by a single organisation. Its recommendation is rather, as already noted, that the Government should initiate conversations with those concerned in the field of social survey to consider what action should be taken. Moreover, while *Planning* is concerned in this broadsheet solely with the social survey and not with the whole field of social research, laying down as one principle that any new organisation should be concerned solely with the social survey, with terms of reference as specific as possible without unduly limiting the field of action, it deals also with two points that the Clapham Committee on the Provision for Social and Economic Research appears to have overlooked in its report. Neither the detailed study of the use made by Government of its own research workers in this field, nor the use which could be made of independent research bodies, appears to have been considered by the latter Committee.

On the first point, the recommendations of P E P have already been noted; and it need only be observed further that examples of duplication and overlapping between the regional research officers of the Board of Trade and the Ministry of Town and Country Planning could easily be cited. On the second point, P E P is clearly fully alive to the potentialities of the independent research organisations, such as the National Institute of Economic and Social Research, the West Midlands Group, the Northern Industrial Group, the Association for Planning and Regional Reconstruction, apart from the interest, for example, of the Royal Statistical Society. Consultation with such interested parties should be the first step towards a precise recommendation as to the constitution of any new organisation.

Beyond this, P E P emphasizes that it is desirable that any such institute or other organisation should not be within the Government itself. Stress is rightly laid on the undesirability of canalizing within any direct government control the scientific work which is developing directly and experimentally. The establishment of a network of national and regional research associations which might represent in the economic field the equivalent of the research associations of the Department of Scientific and Industrial Research, as suggested in the *Economist* in commenting on the Clapham Report, might well encourage the free interchange of ideas between all kinds of organisations and individuals, and be free from the inherent defect of the industrial research association itself. If it could be done informally, the required co-ordination might thus be secured without an undesirable degree of control. Equally, however, any organisation established must have adequate funds and would almost certainly require a Treasury subsidy, or endowment by a charitable trust. A first step might, for example, be the endowment of the exchange of information on work in progress at present undertaken by the National Institute for Economic and Social Research.

This P E P broadsheet, therefore, makes a useful complement to the Clapham Report, the basic argument of which as to the need for more factual inquiries it strongly supports, both from the point of view of the social services themselves and also from that of the public benefit derived from applied social research. Neither document, however, emphasizes one factor which must be remembered if the fullest benefit is to be derived from the social survey, still more from the extended provision for social and economic research recommended by the Clapham Committee—the need for economists to utilize experience from other fields. The detailed studies of problems on the boundaries between economics and other sciences—for example, an examination of the trend of technical efficiency in British industry—involve contributions from the engineer, the statistician, the accountant, the social historian, the personnel manager and the industrial psychologist. One of the main problems is not the organisation of co-operation between social scientists in the strict sense, important as that aspect may be in view of the urgent need for making the utmost use of man-power, so much as the organisation of that effective collaboration between workers following different disciplines in the attack on common problems. If the social survey can be handled so as to promote such co-operation and mutual understanding, it will prove not merely an indispensable tool of government, but also a most effective instrument for the stimulation of that creative thought at the boundaries of knowledge which again and again has proved the precursor of the advance of science.

GENETICS IN THE U.S.S.R.

The New Genetics in the Soviet Union
By P. S. Hudson and R. H. Richens. Pp. 88. (Cambridge: Imperial Bureau of Plant Breeding and Genetics, 1946.) 6*s*. net.

FOR more than ten years, biologists have been puzzled by reports from the U.S.S.R. about the 'new' genetics' of Lysenko and his school. According to these reports, Lysenko had repudiated Mendelism, and in its place he had established a new genetics, founded on the authority of Darwin and Michurin, and elaborated from his own experiments. The new

genetics took no account of segregation. It did not admit phenotype or genotype. It denied that chromosomes played any special part in heredity. It claimed that inherited characters were transmitted through the sap from stock to scion in grafts. It demonstrated that in open pollination, picturesquely called 'love marriage', the ovum selects the gamete it desires. It contrasted the outward appearance of a plant (called its 'shirt') with its physiological character (called its 'soul'). It condemned the work of Mendel, Bateson and Morgan as clerical, bourgeois-capitalistic and fascist. It disdained the use of statistics, controls and such-like experimental techniques. It fought its way to recognition with the weapons of the medieval schoolmen: appeal to authority; *a priori* assumptions based on dialectical materialism; and the compelling pragmatic test that, by the new genetics, nurture henceforth takes charge over nature.

This intellectual eruption, needless to say, severely shook Soviet biology. There was a period during 1932–40 of bitter controversy. Vavilov and Karpechenko vanished during the fight. Serebrovsky and Dubinin retired disillusioned to their institutes. But Lysenko received the applause of the Soviet press and was awarded various public honours. It seemed to biologists outside the U.S.S.R., who were unable to weigh the issues for themselves, that the new genetics had ousted the old.

Lysenko writes in such an obscure style that a knowledge of Russian alone is quite inadequate equipment for a study of his views; one needs to know also something about the Russian character, and something about the application of dialectical materialism to science. Dr. Hudson and Mr. Richens have all these qualifications, and they have written an important essay, in which they summarize in a masterly way the philosophical and psychological origins of Lysenko's views, the experimental evidence, and the logic (or lack of it) used to interpret this evidence. Fantastic as Lysenko's claims may appear to British biologists, they nevertheless deserve careful examination—we did, after all, overlook Mendel for thirty-six years. Hudson and Richens have disengaged the problem from all the violent prejudices which surrounded it. They have approached it in the best traditions of scholarship; important quotations are even reproduced in the original Russian in footnotes, and there is a summary in five languages. They are most sympathetic to Lysenko. They are so anxious to do him justice that they excuse his naïve terminology and his ignorance of contemporary genetics; and they are almost orientally apologetic every time they bring a verdict against him. Thus on the question as to whether Lysenko's evidence for 'love marriages' among mass pollinated plants is convincing, they conclude: "it is difficult to come to any answer other than a decided negative". The whole essay is a virtuoso piece of literary meiosis. Lysenko could not have had his case put more fairly: indeed, he could not have put it nearly so fairly himself.

And what is his case? Hudson and Richens show how the new genetics has its source in Darwin, often from some tentative suggestion Darwin made; so that Darwinism in Russia means something quite different from Darwinism in England. They show how Darwin's views have been clothed in the language of dialectical materialism. They record how, in 1932, a resolution was passed in Leningrad that genetics and plant breeding were to conform with dialectical materialism, so that Lysenko enlisted the State on his side. They give the most objective account ever written in English of the controversy during 1932–40. They examine the argument by authority and the denunciation of the seven heresies of genetics. They describe Lysenko's use of the "elastic hypothesis" which contains all the facts you like and explains none of them. They review the experimental evidence for the control of heredity by environment, and they reluctantly decide it is "not compelling". They discuss Lysenko's interpretation of this evidence, and they register gentle but firm disapproval. They give a résumé of Lysenko's destructive attack on Mendelism.

In spite of the authors' urbanity, the new genetics emerges from this essay in a pretty bad state. Lysenko claims to have changed heredity by manipulating the environment and to have rejuvenated pure lines by intravarietal crossing: the authors show that his experiments are capable of other interpretations quite consistent with the old genetics. Lysenko claims to have influenced the heredity of plants through grafting: the authors show that his data are incapable of any interpretation, and that one of his tables is even inconsistent within itself. Lysenko claims to have demolished the old genetics: the authors show that his criticisms are applicable only to the genetics of thirty years ago. Lysenko's attitude to modern genetics outside his own school is (as I know through conversation with him) one of militant obscurantism. Hudson and Richens, by contrast, have analysed the most improbable claims of the new genetics with quiet care; and they even support Lysenko's just complaint that other geneticists have not taken the trouble to repeat his experiments.

The authors point out that they cannot offer opinions on two matters of interest: the exact way in which Lysenko does his experiments, and the present state of the new genetics in the U.S.S.R. I can offer some comment on these two matters.

First, as to the experimental technique in the new genetics. The experiments are carried out on very small populations of plants. For example, an experiment on 'shattering' the heredity of winter wheat (to turn it into spring wheat) occupies a plot of ground about 7 ft. by 3 ft. An experiment on changing the nature of Wohltmann potatoes occupies two rows about 20 ft. long: one row, the control, is heavily infected with virus, though this was denied by Lysenko. An experiment on 'love marriage' in rye occupies about 7 ft. by 3 ft. of ground. Experiments on the transmission of heredity through grafts, using tomatoes, are done with about 20–30 plants, sometimes without controls. The technique of emasculation seemed unreliable to me; and I was told by Lysenko that it is only since 1940 that emasculated flowers have been bagged before pollination; before that no precautions were taken to exclude stray pollen. Since Lysenko rejects the idea of pure lines, no particular care is taken to use homozygous material for experiments; in fact, Lysenko seems to assume that any variety with a name to it is genetically homogeneous—an assumption which should not be made for Russian varieties. Some of the strains of tomatoes are markedly heterozygous, and some suffer from spotted wilt, which causes a mottling of the fruit which Lysenko attributes to a change in heredity. When experiments are carried into an F_2 generation, not all the seed from a parent plant is sown, but only seed from 'selected' fruits or ears. Statistical treatment

of the data is forbidden ; it was a member of Lysenko's staff who told me that Darwin's work is convincing without statistics ; why should anyone require statistical evidence of Lysenko's work ?

As to the present state of the new genetics in the Soviet Union, it is safe to assume that Lysenko's school is well past its zenith. It is true that he is still a great demagogue among the peasants and on the collective farms. It is true that, in the University of Leningrad, Turbin (who has the chair of genetics) and Prezent (who has the chair of Darwinism) maintain a school of the new genetics, and Sinnott and Dunn's text-book is passed in secret from student to student as though it were an inflammatory tract ; and Lysenko has tried (see his journal *Yarovizatsia*, 1939 and 1940) to suppress all teaching of Mendelism in Russia. But side by side with the new genetics there exists, in uneasy truce, a school of the old genetics which is setting the pace on world standards in such fields as population genetics and the use of colchicine-induced polyploids in plant breeding. The University of Moscow has flourishing genetics schools under Serebrovsky and under Schmalhausen, where Khvostova has recently repeated Lysenko's work on graft hybrids in tomato and shown that his results are due merely to heterozygosity. It is fairly safe to say that most biologists in the U.S.S.R., while ready to admit Lysenko's skill as a practical agriculturist, are deeply embarrassed by the new genetics, and are gradually turning their backs on it.

There are very few matters for criticism in this essay by Hudson and Richens : only a few minor errors not worth special mention ; and a mild complaint at the scholarly but rather fastidious transliteration of Russian names into unfamiliar English equivalents. The authors have done a great service to international understanding in biology. They hope their work will remove prejudice on both sides. That is perhaps too much to hope ; but if it exposes the new genetics as a throw-back to the days of Thomas Aquinas, it will undoubtedly be welcome, and not least in the U.S.S.R. itself. ERIC ASHBY

REGISTRATION OF ORGANIC REACTIONS

Synthetische Methoden der organischen Chemie
Von W. Theilheimer. Repertorium 1. Pp. viii + 224. (Basel und New York : S. Karger, 1946.) 25 francs.

THESE are days of registration and regimentation, and even organic chemistry cannot escape. The increasingly rapid expansion of this branch of science, since the inception of the Kekuléan theory of organic molecular structure in 1858, has been marked by a bewildering accumulation of organic compounds and reactions.

The systematic registration of the 'monstrous regiment' of new compounds, produced in their hundreds of thousands by a mounting army of research workers, has been well accomplished in such works as Richter's "Lexikon der Kohlenstoff-Verbindungen" (3rd edition, 1910–12), Beilstein's "Handbuch der organischen Chemie" (4th edition, 1918–39), and Heilbron and Bunbury's "Dictionary of Organic Compounds" (2nd edition, 1943). As a result of the Second World War, however, the monumental and invaluable Beilstein—"the Charlie's Aunt of organic chemistry"—has been halted in its course, and now lies stranded far behind the rushing tide of new compounds. Here, fortunately, the position is ameliorated by the regular publication of various series of chemical abstracts of current literature.

The effective registration of organic reactions has reached a far less satisfactory position than that of organic compounds. Earlier generations of researchers hailed with delight and relief, even in the days when the technique of organic chemistry was comparatively simple, the issue of successive editions of Lassar-Cohn's "Arbeitsmethoden für organisch-chemische Laboratorien" (1890, 1893, 1903 and 1907). Later on, this was followed by Houben-Weyl's massive work in four volumes, entitled "Die Methoden der organischen Chemie" (2nd edition, 1921–24). In recent years, owing more to the accumulation of fine detail concerning known reactions rather than to the discovery of essentially new ones, the task of carrying out a quick and effective survey of knowledge in this field has grown ever more difficult. Several attempts have been made to remedy the position by issuing serial works on organic synthetic methods, among which may be mentioned in particular two valuable American publications: (1) "Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals" (1921, onwards), and (2) "Organic Reactions" (Vols. 1 and 2, 1942, 1944). Each annual volume of the first work contains authenticated particulars for a haphazard collection of compounds ; each volume of the second work is a "collection of about twelve chapters, each devoted to a single reaction, or a definite phase of a reaction, of wide applicability".

Dr. Theilheimer's new venture is of still another type, for his object is to undertake periodically a systematic registration of new synthetic organic reactions and also of adaptations and extensions of known methods to be found in the current literature. This is a novel project with great potentialities. In the first volume, now under notice, the literature of 1942–44 is reviewed ; a second volume is projected to cover the years 1945 and 1946 and to gather stray references from the years of the Second World War ; and further volumes will then follow at yearly intervals.

As there is no generally accepted classification of organic reactions, the author has worked out a tentative system of his own, based ultimately upon the characters of the new linkages formed in the reactions concerned. Four major ways of forming such linkages are recognized for the purpose of the classification, namely, uptake (*Aufnahme*), rearrangement (*Umlagerung*), exchange (*Austausch*), and elimination (*Abgabe*). Each type of process is represented by a special symbol, and still other symbols are used to indicate ring-closure, ring-fission and electrolysis. In all, the work contains notices of 793 reactions, with brief indications of experimental conditions and yields and references in each case to the original literature. A systematic summary of these reactions is given on a single page at the end of the volume, and there is an ordinary index for readers who may not take kindly or easily to the author's new system of representation. As an indication of the comprehensive scope of the work, it may be noticed that the index entries given under the heading "Ketone" exceed fifty. The work will be examined with keen interest by research workers in organic chemistry ; but experience only can determine whether the system of registration will find general acceptance, although there can be little doubt that something of the kind is much to be desired. JOHN READ

AMERICAN TECHNIQUES IN PHYSICAL CHEMISTRY

Physical Methods of Organic Chemistry
Edited by Arnold Weissberger. Vol. 2. Pp. vii + 737–1367. (New York: Interscience Publishers, Inc., 1946.) 8.50 dollars.

VOLUME 2 of this series of reference books has the same general merits and defects as Volume 1, which was reviewed a short time ago (*Nature* of May 11). It includes, however, a decidedly larger proportion of those physico-chemical methods which are capable of wide and novel application in the very fields of organic chemistry which are at present undergoing the most rapid development, and therefore may prove to be much the more useful of the two volumes.

It is apparent again that different contributors have treated their selected subjects in styles which range from highly detailed accounts of physical principles and apparatus to more general outlines of principles which are then illustrated by experimental methods chosen so as to show the scope of the particular technique. In the opinion of the reviewer, this latter approach is the better one from the point of view of the general reader.

As extremes in treatment one may contrast the article on 'polarimetry' by W. Heller, which, in a hundred pages, deals only with the physics of double refraction, and with the principles of different designs of polarimeters, with two much more concise articles by L. Michaelis on potentiometry and on the determination of magnetic susceptibility. These include no more than the essential minimum of physical theory, describe only the essential features of typical apparatus, and then concentrate on showing the scope and importance of accurate measurement of, for example, hydrogen-ion potential, oxidation-reduction potential, or the evaluation of magnetic moments.

A brief article on mass spectrometry by D. W. Stewart is again valuable for showing the applications of this subject in the examination of organic substances subsequent to isotope exchange, and in the analysis of complex mixtures of hydrocarbons.

Two articles by W. West on spectroscopy and spectrophotometry, and on colorimetry, photometric analysis and fluorimetry, strike quite a good balance between the space allocated to physical principles and apparatus and to indications of the applicability of these methods. In view of the great and growing importance of all these techniques in both organic and inorganic analysis the editor might, with advantage, have allocated more space to each of these articles. The many inherent dangers, as well as the advantages, of adducing information from spectroscopic or colorimetric data might then have been set forth more clearly.

Accounts of conductometry by T. Shedlovsky, and of determination of radioactivity by W. F. Bale and J. F. Bonner, Jr., deal essentially with physical apparatus, and with the precautions needed for the attainment of high accuracy, rather than with the value of such measurements. In the latter case this is especially to be deprecated, in view of the very important uses of radioactive isotopes in biological chemistry. For reference purposes, however, both articles are useful sources of exact information. The same unfortunately cannot be said of an article by C. P. Smyth on dipole moments, which fails badly on account of its quite inadequate length.

A hundred-page article on polarography, by O. H. Müller, attempts to review the especial applicability of this important technique in relation to problems of organic chemistry, but gives on the whole a rather confused impression of the complexity of the subject, making it evident that polarography is still in such an early stage of development that newcomers to the technique would be well advised to start by learning its first principles in the simpler field of inorganic analysis. Müller very wisely describes the construction and use of simple polarographic apparatus and merely indicates the existence of manufacturers' automatic outfits.

Though every reader of these two volumes will, like the reviewer, find much to criticize therein, he is sure to find himself making continual use of them when in need of precise information concerning modern physico-chemical apparatus. "Physical Methods of Organic Chemistry" should certainly be included on the reference shelves of any chemical research laboratory.

W. A. WATERS

ITALIAN RADAR

Introduzione alla Radiotelemetria (Radar)
Apparecchi e nozioni entrati nell'uso corrente. Per Prof. Ugo Tiberio. Pp. 277. (Roma: Editore Rivista Marittima, 1946.) 300 lire.

IN view of the outstanding achievements of Britain and the United States in radar development, it is at first sight somewhat surprising that the first serious text-book on radar to be published should come from Italy. When we consider, however, that for Italy the War finished a good eighteen months before it ended for us, it is not difficult to see that scientific men in that country have had more time to write of their work than British men of science, and have been less concerned with difficulties of security. Indeed, there are several British and American books on radar technique under way which take the development of the subject far beyond the scope of the present book, and these will be looked for with interest by a wide variety of readers. For the radio engineer, of course, British developments have been made available in the excellent series of papers submitted to the recent Radiolocation Convention held by the Institution of Electrical Engineers.

The present volume is mainly of historical interest as it gives an account of the Italian research on radar from 1935 to the end of hostilities. Some of their radio-frequency technique, which now seems crude, was in the days before the War quite advanced. The advances made during the War, however, appear to be small, and how much came from German sources is difficult to ascertain. The book deals mainly with radar used on the ground and on ships for early warning of the approach of aircraft and of ships and for fire control. For early warning, wave-lengths in the region of 1½ metres were mainly used, and for fire-control advantage was taken of the higher definition obtainable by the use of higher frequencies. Although experiments seem to have been made on a wave-length of 10 cm. using klystrons and split-anode magnetrons, most of the equipment in use appears to have operated on wave-lengths of the order of 70–80 cm.

There is no mention of high powers in the centimetric band such as were used in British and American radar.

Surprisingly, too, there appears to have been only slight appreciation of the technique of using a single aerial for transmission and reception. Such notable advances as the 'plan position indicator', used for forming a 'radar' map, seem also to have been missed.

The part of the book dealing with the elementary principles of radar will be of most interest to readers other than radio engineers. The treatment is simple and lucid, though rather sketchy. In particular the effect of the earth on aerial polar diagrams is very fully dealt with.

The main defect of the book is its complete lack of photographs. One gets a much better idea of the state of technical development from a photograph than from a bare circuit diagram. The performance of radio equipment in the ultra-high frequency region depends so much on engineering technique and lay-out that very little impression of the quality of the equipment can be obtained without a picture. There is a vast gap between a schematic idea and a finished operational equipment. There is little to indicate that that gap was often filled. R. A. SMITH

INFRA-RED AND RAMAN SPECTRA

Infra-Red and Raman Spectra of Polyatomic Molecules

By Prof. Gerhard Herzberg. (Molecular Spectra and Molecular Structure, Vol. 2.) Pp. xiii + 632. (New York: D. Van Nostrand Co., Inc., 1945.) 9.50 dollars.

IT is now becoming more widely realized that infra-red spectroscopy has grown into a powerful new method for analysis and structural diagnosis, and as such it must be used by many who have hitherto had little knowledge of either the relevant theory or the experimental technique. To this extent any new book on the subject will be studied with interest. Prof. Herzberg's new monograph on polyatomic molecules, like that on diatomic molecules preceding it, is an admirable one. It is important, however, to understand just what this book sets out to cover, since in spite of its very great value it cannot, taken alone, be regarded as a manual for new workers in the field.

Until about ten years ago, most infra-red measurements were directed at the elucidation of spectral theory and the determination of molecular structure. The large number and arrangement of the energy-levels of even the simplest polyatomic molecules are far more complex than with diatomic molecules, and the selection rules which determine the possible transitions between the levels are also more involved. If it is possible to derive the energy-levels from the spectral data, important structural properties such as the moments of inertia and vibrational frequencies are obtained, and even a partial analysis may provide enough information from which many of these quantities can be determined. For such analyses, and particularly in the assignment of vibrational frequencies, a correlation of the infra-red spectra on one hand and the Raman spectra on the other may be not only valuable, but essential, if a complete solution is to be reached.

The present book provides the most exhaustive and polished discussion of these matters yet published, and is amply illustrated by many examples of molecules which have actually been studied. As is well known, the symmetry properties of molecules play an important part in determining not only the arrangement of the molecular vibrational and rotational energy-levels, but also the selection rules. Prof. Herzberg has wisely devoted much care to a lucid account of characteristics of symmetry, with excellent illustrative diagrams. There is a thorough account of the nature of the potential energy function for molecular vibrations and of the methods for calculating the vibration frequencies in terms of the nuclear masses and force field within the molecule. Experienced spectroscopists will welcome this lucid survey of a highly complex problem, and will agree about the clarity with which the author has prepared it. There follows a detailed account of internal torsional motions, inversion doubling as found with ammonia, the relationships between the vibrational frequencies of isotopic molecules, and other related matters, and there is a valuable compilation of the results for most molecules so far examined.

The rotational fine structure associated with different kinds of vibration band is then considered by reference to molecules in different symmetry classes, and complications resulting from interaction between molecular vibration and rotation are considered in some detail. Here, too, the book will be regarded as a work of reference for many years to come. For molecules with somewhat larger moments of inertia where the rotational fine structure of the vibration bands cannot quite be resolved, the envelope of the structure can frequently be useful, and the possible types are briefly mentioned.

In a final short chapter, some applications are considered, and the methods of computing thermodynamic functions from spectroscopic data are summarized. The bibliography and index are good.

In all the above connexions, which really involve the various problems of molecular dynamics, there can be little but praise for the thorough way in which the author has set out the work, and any reader who wishes to understand the fundamental principles of the subject could find no better guide. On the other hand, the emphasis seems now to be passing to the more chemical applications, where more complicated molecules are involved. As a rule these molecules possess no symmetry, have large moments of inertia, and can be examined only in the liquid or solid state. At present, interest centres for the most part on the correlation of vibrational spectrum with the presence of internal molecular groupings, and such correlations can only be made by a semi-empirical method of comparison using related groups of molecules. There is now reason, moreover, to hope that more can be learnt from the spectra of solids and liquids about the intermolecular forces, and the technique is being applied successfully in the study of crystals and macro-molecules. The molecular dynamics of long-chain molecules, too, introduces a somewhat different problem from those considered earlier. These newer aspects are treated only briefly in the present book, which may in this respect therefore be less directly useful to the technologists. There is also little mention of the whole new field of infra-red analysis, nor any account of the experimental methods which have so rapidly improved during recent years.

These omissions do not at all affect the masterly presentation of the particular topics with which the author has dealt. Indeed, it may be that to lengthen the book would have been a disadvantage. Certainly all spectroscopists will want to refer to it, and many will regard it as a close companion.

H. W. THOMPSON

TERCENTENARY OF JOHN FLAMSTEED (1646–1719)*

By Sir HAROLD SPENCER JONES, F.R.S.
Astronomer Royal

TO-DAY [August 18] we commemorate the tercentenary of the birth of John Flamsteed, the first Astronomer Royal and one of the greatest practical astronomers of his day. I am glad to have the opportunity to pay a tribute to the first of my predecessors, who laboured with single-minded devotion at Greenwich for forty-four years. It is appropriate that this commemoration should be held in this church: for Flamsteed held the living of Burstow for thirty-five years, he paid frequent visits here, and in the chancel of this church he lies buried.

John Flamsteed was born at the village of Denby, several miles northward from Derby, on August 19, 1646. His parents were, in his own words, "of known integrity, honesty and fortune, as they were of equal extraction and ingenuity". When barely three years old he lost his mother, his father being left with the care of a daughter, then not a month old, and of John, who was a child of a weakly constitution. He was educated at the free school of Derby, where his father lived. At the age of fourteen, he contracted severe rheumatic trouble, as a result of river-side bathing. The effects of this he felt throughout his life; he suffered from perpetual ill-health, "my distemper" as he called it. He became so weak that he was scarcely able to go to school and, when not quite sixteen years old, he left school for good. At school his studies had consisted largely of history and Latin. Being lent a copy of Sacrobosco's "Spheres" in Latin he soon began to show an inclination towards mathematics and astronomy, while his father taught him arithmetic. He observed and recorded an eclipse of the sun and learned how to predict eclipses and to calculate the places of the sun. His practical inclinations were shown in the construction of dials and of a quadrant and in grinding lenses for telescopes.

Self-taught by dint of assiduous reading and study, Flamsteed acquired a wide knowledge of astronomy. His observations, made with a small telescope, showed him how deficient were the current astronomical tables. In 1669 he calculated some occulations of stars by the moon for the year 1670, which were transmitted by a friend to Lord Brouncker, the president of the Royal Society. This brought Flamsteed into communication with Oldenburg, the secretary of the Society, and with John Collins, a fellow of the Society, who maintained an extensive correspondence with Newton, Gregory and other prominent fellows.

In 1670 Flamsteed, at his father's suggestion, went to London to become personally acquainted with his learned correspondents. He visited Oldenburg and Collins, who took him to the Tower to meet Sir Jonas Moore, the Surveyor-General of the Ordnance, a mathematician and a fellow of the Royal Society. This was an important event in Flamsteed's life, for Sir Jonas Moore took a great interest in the young astronomer, and became his warm friend and patron: to his help and encouragement Flamsteed owed a great deal. Later in 1670 Flamsteed entered himself at Jesus College, Cambridge and in 1674 he took the M.A. degree. While in Cambridge he made the acquaintance of Dr. Barrow and Mr. Newton.

Flamsteed spent some part of his time in astrological studies, as was not uncommon at that time. But in 1673 he wrote an ephemeris wherein he "showed the falsity of astrology and the ignorance of those who pretended to it". At Sir Jonas Moore's suggestion, he prepared an account of the tides for King Charles II. He also constructed a barometer (a "weather glass" as he called it) and afterwards gave one to Sir Jonas Moore; he, in turn, presented weather glasses to the King and the Duke of York, giving them also the directions which Flamsteed had prepared for judging the weather from their rise or fall. This, Flamsteed records, brought him "more than ordinary regards from them".

Sir Jonas Moore had shown his interest in Flamsteed in a practical way by offering to pay £10 a year and to obtain a further £10 from two friends, for the employment of an assistant to help him with his observations and computations. On taking his degree, Flamsteed designed to take orders and to settle in a small living near Derby, which was in the gift of a friend of his father. From his early years he had been of a very pious and religious turn of mind. In 1675 he took orders at Ely House, at the hands of Bishop Gunning.

Flamsteed, in the account of his life, says "My desires have always been for learning and divinity; and although I have been accidentally put from it by God's providence, yet I have always thought myself more qualified for it than for any other employment; because my bodily weakness will not permit me action and my mind has always been fitted for the contemplation of God and his works".

Plans were at this time under discussion for founding an observatory in London, under the auspices of the Royal Society. Sir Jonas Moore was greatly interested in this project and invited Flamsteed to London to consult him on the subject. He resided at Sir Jonas Moore's house in the Tower, where he carried on his astronomical observations. But while this scheme was under consideration, the event happened which definitely turned Flamsteed's life into a new direction.

At this time there was no satisfactory method of finding the longitude of a ship at sea. The need for a reliable method had become urgent. The proposal had been made that the longitude should be formed by comparing the position of the moon (got by observing her distance from the fixed stars) with her places given by astronomical tables. A Commission, which included Lord Brouncker, the principal officer at the Navy Board, Sir Jonas Moore, and Flamsteed, was set up to report on the plan. The Commission reported (Flamsteed tells us) that this method was indeed the most likely to prove useful to our sailors because most practicable; but that the catalogue of fixed stars was both erroneous and incomplete; that the best tables of the moon's motions were inaccurate; and that these errors would sometimes cause an error of three hundred leagues in the determination of the longitude; so that our sailors could expect no help from this method till both the places of the fixed stars were rectified, and new tables of the moon's motion made, that might represent her place in the heavens to some tolerable degree of exactness; for which a large stock of very accurate observations, continued for some years, was altogether requisite, but wanting. That therefore His Majesty would give a great and altogether necessary encouragement to our navigation

* Substance of an address delivered at a tercentenary service held in Burstow Parish Church on Sunday, August 18.

and commerce (the strength and wealth of our nation) if he would cause an observatory to be built, furnished with proper instruments, and persons skilful in mathematics, especially astronomy, to be employed in it, to take new observations of the heavens, both of the fixed stars and planets, in order to correct their places and motions, the moon's especially; that so no help might be wanting to our sailors for correcting their sea charts, or finding the places of their ships at sea.

When the report was shown to the King, he startled at the assertions of the fixed stars' places being false in the catalogue; said, with some vehemence "He must have them anew observed, examined and corrected, for the use of his seamen", and further, when it was urged to him how necessary it was to have a good stock of observations taken for correcting the motions of the moon and planets, with the same earnestness "he must have it done". And when he was asked who could, or who should, do it? "The person (says he) that informs you of them." The outcome was that Charles II decided to found an observatory and Flamsteed was appointed to take charge of it. Chelsea and Hyde Park were considered as possible sites, but in the end, at the suggestion of Sir Christopher Wren, Greenwich was chosen, Charles II giving a site on the highest ground in the Royal Park at Greenwich. Wren was appointed architect of the observatory, which was built at a cost of £520, defrayed by the sale of old and decayed gunpowder. The foundations were laid in August 1675 and the building was completed by July 1676. Flamsteed was appointed, in the terms of the Royal Warrant, "our astronomical observator" (the designation Astronomer Royal was given at a later date: Flamsteed usually signed his name as M.R.—Mathematicus Regius).

He was granted an allowance of £100 a year; from which £10 was deducted as tax. Inadequate as this was, it was often in arrears. Although the Committee had recommended that the observatory should be provided with proper instruments and with skilled persons to observe with them, no instruments were, in fact, ever provided by the Government and the only assistance given was that of a common labourer. Flamsteed's patron, Sir Jonas Moore, generously presented him with a large iron sextant and two clocks by Tompion, the most celebrated maker of clocks of the day. He borrowed also a small quadrant from the Royal Society, but on the death of Sir Jonas Moore, this was called back.

With the sextant it was possible to observe only the relative positions of the stars. An instrument fixed in the meridian was required to determine their absolute positions. Until such an instrument was provided it was not possible for him to achieve the practical ends for which the observatory had been established. Flamsteed made repeated applications to the Government for a mural arc; it was often promised, but it never came. In 1681 he therefore had a mural arc made at his own expense, but it proved to be not sufficiently rigid in construction, and the observations made with it were not of the accuracy that was needed. In 1684 Lord Keeper North presented him with the living of Burstow; soon afterwards his father died and Flamsteed, finding his income somewhat increased, decided to construct a new mural arc, much stronger than the former. This was completed in 1689, at a cost of upwards of £120. The Master of the Ordnance had promised that the cost should be repaid to him; but the promise was not kept and not a farthing of the money he had expended was ever refunded to him.

The tasks that Flamsteed had undertaken were Herculean. They were, first, the construction of a catalogue of the fixed stars, more extensive and more precise than all existing ones; secondly, the systematic observation of the sun, moon and planets with the view to revising the theories of their apparent motions and to constructing tables from which their positions could be computed with the desired accuracy. These tasks were far beyond the capacity of one man, for they involved not merely continuity and regularity of observation over many years, but also extensive computations. It was essential for Flamsteed to have assistance; as none was provided by the Government, he had to defray the cost out of his own pocket. To meet his expenses, it then became necessary for him to take private pupils for instruction in mathematics and astronomy. An additional burden was put upon him by the King who ordered him to instruct two boys monthly from Christ Church Hospital in mathematics. These calls on his time necessarily distracted him from carrying on his astronomical observations with the expedition that he desired. In 1710 Flamsteed stated that he had spent upwards of £2,000 above his salary in furnishing instruments and in hiring assistants and computers.

Under such disheartening conditions and with his persistent ill-health, it was surprising that Flamsteed was able to accomplish so much. His observations were planned with a careful attention to accuracy in their most minute details; he introduced new methods into practical astronomy, many of which are in use to-day; an immense mass of computations were carried out in a systematic and orderly manner, to correct the theories and to improve the tables of the sun, moon and planets, and to elucidate intricate points in practice and theory. He established the fundamental essentials of practical astronomy on sure foundations, which served as a landmark for his successors. In accuracy his observations far exceeded those of his predecessors or contemporaries; they are, in fact, the earliest observations from which the phenomenon of aberration is clearly deducible. In addition he maintained an extensive correspondence with the principal astronomers and scientists of his day.

Flamsteed had realized more clearly than any of his contemporaries that a large stock of accurate observations, continued for many years, was needed to accomplish the tasks on which he was engaged. But it was not long before demands began to be pressed upon him for the publication of his results.

These demands Flamsteed resisted, claiming the right to decide for himself when his results were sufficiently complete and accurate to justify publication. This question of publication was to involve Flamsteed in acute controversies with Newton and Halley, which embittered the later years of his life. For some years Flamsteed and Newton maintained a friendly correspondence and Newton often visited the observatory. Flamsteed had a high regard for Newton; he said that "Mr. Newton's approbation is more to me than the cry of all the ignorant in the world". Newton was occupied at this time with the theory of the motions of the moon; he made frequent requests for Flamsteed's observations and at various times asked him to make observations at certain specified periods. Flamsteed complied with all these requests; he seems, however, to have resented that Newton "was too inconsiderate as to presume he had

a right to that which was only a courtesy" and that "he said not one word of his obligations or debt to the Royal Observatory". The relations between the two men gradually became cooler and eventually widened into an open breach.

At length Flamsteed began to consider the question of publication of his observations and of his great catalogue of stars. He planned to bring out a single great work, which would be a monument to his industry and skill, and would raise the name of England in the astronomical and scientific world. He prepared an estimate of the number of pages; but at this juncture, Prince George, consort of Queen Anne, having learnt of Flamsteed's labours, proposed to have the work printed at his own expense. A body of referees which included Newton, then president of the Royal Society, was appointed to inspect Flamsteed's papers; this was done, and it was recommended that all should be printed. Flamsteed was instructed to hand over a copy of his observations and of his catalogue; but as the catalogue was incomplete and imperfect, he deposited a sealed copy, not for printing but as a guarantee of furnishing a revised and completed copy at a future date. The printing proceeded very slowly and the first volume alone had been completed by 1708, when Prince George died. In 1711 the printing was resumed by order of Queen Anne, but unknown to Flamsteed; a garbled and incorrect edition of the observations with the mural arc and of the imperfect and incomplete catalogue, which had been deposited under seal, was published in 1712 without Flamsteed's consent. It is not surprising that this unauthorized publication was deeply resented by Flamsteed.

A further source of trouble to Flamsteed was the appointment in 1710 of a Board of Visitors of the Observatory with power to demand from Flamsteed each year a true and fair copy of his observations. For Flamsteed, not without reason, looked upon the observations as his own property. It must be remembered that the instruments with which they were made were his own; "the very books in which these observations were entered, the pens and the ink with which they were written, the paper on which they were copied, were all furnished at his own cost, and not at the expense of the public, who contributed nothing but his paltry salary". This question of the proprietorship of the observations made at the Royal Observatory came up in 1762, on the death of Bradley, the third Astronomer Royal. Bradley's executors took possession of his observations and maintained their right to them in a lengthy lawsuit brought by the Crown, even though Bradley was supplied with instruments of the best sort at the public expense and, moreover, had an addition of £250 per annum to his salary. With how much greater right did Flamsteed then regard his observations as his own property!

Flamsteed resolved to publish a correct version of his observations and of his catalogue at his own expense. With this end in view he applied to Newton for the return of the manuscript copy of the catalogue and of 175 sheets of observations. Being unable to secure them, he was compelled to recopy them all for the press at an expense of nearly £200.

Whilst engaged on this work Queen Anne died, there was a change of ministry, and people more friendly to Flamsteed came into power. He was able to secure three hundred out of the four hundred copies of the garbled and incorrect volume that had been printed and he publicly burnt them "as a sacrifice to heavenly truth". He then began printing a revised edition at his own expense, but he did not live to finish the task. In 1719 he died before the printing was nearly completed. It was finished and published in 1725 by the devoted labours of Crosthwait and Sharp, who had been Flamsteed's private assistants.

The "Historia Cœlestis Britannica", in three volumes, containing Flamsteed's observations and his great catalogue of nearly three thousand stars, was the first important contribution to science given by Greenwich Observatory to the world. It opened a new era in sidereal astronomy and stands as an enduring monument to Flamsteed's scrupulous care and unflagging industry and to what he was able to achieve in his forty-four years at the Royal Observatory, in the face of official neglect and very great difficulties. The injustice with which Flamsteed had been treated in his life did not end at his death. The Office of Ordnance attempted to prevent his executors from removing his instruments from the observatory and brought a lawsuit against them; but, as the executors were able to prove that the Office had never paid for any of the instruments, nor even for their repair, the case could not be sustained.

Flamsteed was a man of singular piety; his diaries and letters abound with devout expressions of thankfulness to God. Suffering from continual ill-health, denied the official support which he was entitled to expect, unjustly treated by those who did not appreciate the difficulties with which he had to contend, it is not to be wondered at that in his later years he became embittered. His unwearied perseverance in the face of difficulties and his single-minded devotion to his duties laid the foundations upon which the pre-eminence of the Royal Observatory among the institutions devoted to practical astronomy has been built. He realized better than any of his contemporaries what was most needed in his day for the promotion of astronomy. His work was marked by no brilliant discoveries; but, by unflagging industry and scrupulous care, by systematic observations and insistence upon accuracy, he bequeathed to his successors an immense treasure of observations. His name will always be honoured as that of the first great British observer who established precise astronomy upon secure foundations, and is enrolled among those who have made permanent contributions to the advancement of astronomy.

ANTIBIOTICS IN A POLYPORUS (*POLYSTICTUS SANGUINEUS*)

By Prof. S. R. BOSE
Carmichael Medical College, Calcutta

Introduction

THE success of the penicillin programme suggested to me a search for antibiotics among the Polypores, the group of higher fungi with the study of which I have been connected for more than a quarter of a century. While Fleming obtained penicillin from *Penicillium notatum* growing in his culture plate as an accidental contaminant from the air, and Dubos and Waksman obtained gramicidin and streptomycin from *Bacillus brevis* and *Actinomyces griseus* respectively, growing in the soil, I have collected this fungus, *Polystictus sanguineus* (L.) Mey., from

decomposed wood, logs and bamboo pieces in various parts of India since 1918. *Polystictus sanguineus* is scarlet-red in colour, it has not been reported so far from Europe; but it is regarded by many as the analogue in tropical regions of *Trametes cinnabarinus* (Jack.) Fr. which is common in temperate regions of Europe and America.

Systematic description and an account of the geographical distribution of this fungus was published by me in 1918[1], a study of its artificial culture from spore to spore in 1930[2], and cytological study of basidia of sporophore in 1937[3]. A study of the enzymes of *P. sanguineus* in 1937[4] showed that the activity of enzymes in the fruit-body was much less than that in the young vegetative state, and I followed it up in 1939[5] and 1941[6] with a study of the nature of its colouring substances. Unlike *Penicillum* and *Aspergillus*, Polypores generally are very stable, as their genes seem to be in a very well-balanced state and not liable to mutation[7,8].

Since May 1944, I have taken up a study of the antibacterial activity of the culture-filtrate of *Polystictus sanguineus* in various modifications of Czapek-Dox medium (pH 7) at room temperature varying from 22° to 32° C. The filtrate has been designated as 'polyporin', and the first report of it was published in August 1944[9]. This was followed later with a short paper on the antibacterial action of polyporin in July 1945[10], and with a note in *Nature*[11] on the antibacterial action of polyporin against typhoid, cholera and dysentery organisms and against *B. coli*.

Culture of the Fungus and Collection of the Antibacterial Substance

The fungus was grown in various modifications of Czapek-Dox medium with addition of manganese sulphate, in some cases with pea-seed extract, with green grass extract and autoclaved wheat-bran extract. It was found that pea-seed-decoction with 4 per cent glucose, manganese ($MnSo_4$) and ferrous sulphate gave a very quick and uniform growth, the fungal mat coming to float on the surface of the medium in the course of three or four days; the same effect was obtained with Czapek-Dox medium with addition of 1 per cent 'Difco' peptone. The initial pH of the different media was 7, but it came down to pH 5·8 in the course of about two weeks, the addition of one buffer, either KH_2PO_4 or K_2HPO_4, not having much effect. With double buffers even, pH could not be kept stable round about 7. It is very difficult to maintain a uniform standard of growth in all cases. Usually, the antibacterial activity develops in the course of 2–3 weeks, though there is a great variation; in some cases the antibacterial activity has been noticed in the course of 7–9 days, when there sets in a gradual decline followed again by a rise after a long interval of about 6–8 weeks. We have records of five or six rises and falls of antibacterial titre in the course of about a hundred days. Fresh spores are taken from the fruit-body every now and then, pure cultures from spores for inoculation purposes are maintained in autoclaved solid wheat-bran medium where they grow luxuriantly in the course of about a week; they are then subcultured to nutrient broth for sterility test. If they prove sterile, they are used as seeds for culture-flasks of the Erhlenmeyer or Roux types. Experiments are in progress to maintain a uniform rate of development of the fungus so as to obtain steady production of the antibacterial substance; we have not, however, always found a necessary correlation between the production of antibacterial titre and the growth-factor of the fungus.

After the fungus has grown in the liquid medium for about two weeks, the culture medium is Seitz-filtered and collected in autoclaved tubes and ampoules. They are then stored at room temperature.

Autoclaving the culture at 120° C. for twenty minutes does not affect its antibacterial power in any way; the active material is, thus, thermostable, and it was found to be also non-volatile.

Assay of Polyporin in the Laboratory

The crude filtrate has been tested by the agar-cup method against typhoid, cholera, *B. coli*, *Staphylococcus aureus* and *Streptococcus pyogenes*. Very clear inhibition zones of 18–26 mm. are produced. By dilution-method in broth tubes complete lysis in the course of 2–3 days is obtained, as evidenced by the fact that a subculture from the lysed tube shows no growth at all. By disk-method, a strip of the fungal mat in pure culture was set in a nutrient agar plate of typhoid bacillus culture, when a clear lytic zone of 4 mm. was produced round the strip; similarly, when a circular disk was cut from the fruit-body growing in Nature and placed on a nutrient agar plate of typhoid bacillus culture, a clear lytic zone of 2 mm. was produced round the disk. Distilled water and saline extract of the dried fruit-body in Nature produces a clear lytic zone of 14 mm. against typhoid bacillus and of 12 mm. against *S. aureus* by the agar-cup method.

From these experiments it is concluded that the fungus itself possesses against typhoid bacillus and *S. aureus* lytic properties which become weakened when put in a large mass of liquid medium in artificial culture; hence, the zones obtained in the plates by the agar-cup method are clear inhibition (not lytic) zones where the bacteria become stationary. By concentration of the crude filtrate, lytic zones of 27–30 mm. could be obtained, while the crude filtrate itself produces only clear inhibition zones of 11–15 mm.

Antibacterial Action

Polyporin is acidic in reaction with pH 5·8–6·4, its antibacterial power is not affected by change of pH range from 2–8, it is thermostable as already stated, it can be stored at room temperature of the tropics without any loss of potency, and it can be administered orally, as our laboratory experiments show that its potency is not affected in any way by coming in contact with stomach juice, pepsin and hydrochloric acid. Passage through a Seitz filter does not diminish its antibacterial power. Its action is not inhibited by pus, autolysed tissues, serum or blood. On the other hand, it has been noticed with the agar-cup method that in nutrient agar plate-cultures, the zone of inhibition increases as pH of the nutrient agar is lowered from 7–6·4 and the zone decreases as the pH is increased from 7–7·4.

From a large number of experiments in the course of the last two years, we have obtained sufficient evidence to justify the view that more than one antibiotic material is present in cultures of *Polystictus sanguineus*. Growing in Nature it has to contend for self-existence against diverse groups of pathogenic and non-pathogenic organisms from Protozoa, Bacteria, Actinomyces to other fungi which it happens to come across in its dirty surroundings. A wood-decaying fungus, therefore, is capable of producing

different kinds of antibiotic substances according to the diverse conditions of its growth. Wilkins and Harris[12] have remarked that cultural conditions of fungi in the laboratory, such as composition of the medium, temperature, aeration, etc., determine to a great extent the stimulation or retardation of the production of bacteriostatic substances by them. In his study of the fungistatic powers of *Penicillium notatum*, Overholts[13] holds that penicillin or even notatin is not probably responsible for its antibiotic action against the various fungi of different groups he used in his experiments and that the inhibiting agent may be something entirely different and in no way bound up with the secretion of penicillin.

Toxicity Tests and Animal Experiments

Animal experiments with guinea pigs and rabbits have shown polyporin to be completely non-toxic[9,10]. It is non-hæmolytic and does not produce any pyrogenic effect on intramuscular injection in man. No irritation or any undesirable effect could be detected when the liquid filtrate was applied to the conjunctiva and on superficial open wounds and ulcers in man.

When a vigorous culture of *Vibrio comma* having 1,500 million organisms per c.c. was mixed with 10 c.c. of the crude filtrate (polyporin) having *p*H value of 5·8, and the mixture was injected intraperitoneally into a guinea pig, the guinea pig was saved, while in the control experiment a guinea pig of the same weight, injected similarly with 1,500 millions of *Vibrio comma* alone taken from the same culture, died in the course of twenty-four hours. In another experiment, a twenty-four hours growth of typhoid bacillus (Oxford strain) from nutrient agar was emulsified with autoclaved water and standardized to have 4,000 million organisms per c.c., 0·5 c.c. of this emulsion was mixed with 0·5 c.c. of polyporin (*p*H 7) and incubated for one hour at 37° C.; this mixture (that is, 0·5 c.c. of emulsion and 0·5 c.c. of the filtrate) was then injected intraperitoneally into a guinea pig; the guinea pig survived and remained well; but the control animal of about the same weight injected similarly with 0·5 c.c. of the emulsion only, having 4,000 million organisms per c.c., died in the course of eleven and a half hours. Typhoid bacilli could be recovered in broth culture from the milky peritoneal fluid, heart's blood and congested spleen of the dead guinea pig.

When typhoid vaccine mixed with polyporin was injected subcutaneously into a rabbit, it did not produce any local reaction or uneasiness of the animal, but the control animal similarly injected with typhoid vaccine alone suffered from local swelling and fever. This shows that typhoid vaccine is neutralized by polyporin.

Clinical Trials

In the absence of polyporin of the highest purity, it is not yet possible to state exactly the part polyporin is destined to play in the treatment of infectious diseases. But clinical trials with crude polyporin in our Calcutta hospitals, for the last two years (1944–46), are sufficiently encouraging to justify trials on larger varieties of cases before we try to make a critical comparison of polyporin with other bactericidal agents in the field; it may, however, be claimed that polyporin can be tried in cases where other methods have failed to produce any effective results, as polyporin has not, so far, been found to produce any toxic effect.

Polyporin possesses highly selective action against bacteria. The following is the list of organisms so far tested, which are susceptible to polyporin:

Gram-positive cocci	*Staphylococcus aureus*
	Streptococcus pyogenes
	Streptococcus viridans
Gram-negative bacilli	*B. typhosus*
	B. para typhosus A
	B. para typhosus B
	B. coli
	V. choleræ
	B. flexner.

Staphylococcus aureus Infections

Staphylococcus aureus infections with or without other associated organisms respond to polyporin very effectively and quickly as observed by clinical trials. The prognosis, however, may be expected to be adversely affected by low vitality of the patient, and by the presence of concurrent diseases.

From the above it can be said that polyporin should be introduced as early as possible and the treatment should be pursued vigorously.

Good results have been obtained in the treatment of local *Staphylococcal* infections not accompanied by septicæmia. Of course, it should be admitted that polyporin cannot replace surgery; hence, wherever there is pus, it should be evacuated without delay before beginning polyporin treatment.

It has been found clinically that certain strains of *Staphylococcus aureus* are not amenable to polyporin treatment, of which we do not know the cause.

Striking results have been obtained with the following varieties of cases by local application of polyporin: (1) abscesses and boils (by aspirating the pus cavity and then replacing the pus by polyporin); (2) carbuncles; (3) bed-sores; (4) eye infections (corneal ulcers caused by *Staphylococcus aureus*); (5) ear, nose and throat infections; (6) different kinds of ulcers—stationary ulcers, indolent ulcers, sulphanilamide-resistant ulcers, etc.; (7) infected lymph glands.

Streptococcal infections. Crude polyporin has been applied locally in *Streptococcus* infected cases with success, though only a small number of cases have been tried.

It has been found that polyporin is effective against infections caused by *Streptococcus pyogenes* and *Strepto. viridans.*

The varieties of cases treated by local application of crude polyporin are puerperal sepsis, ulcers and bed-sores.

Cholera. Clinically we have tried crude polyporin orally in cholera cases in our College Hospital. The results are satisfactory, though saline has not been withheld, because we think that saline is a physiological need and we have to replenish the water-loss by some means. Before we are able to establish its efficacy, we have to treat a larger number of cases and compare them with cases where saline alone is administered. The method of administration of polyporin is one ampoule (containing 3 c.c. of the crude filtrate) orally every four hours.

Typhoid and B. paratyphosus A and B infections. Crude polyporin was clinically tried on patients suffering from typhoid and paratyphosus *A* and *B* infections in our College Hospital and on some private cases of local medical practitioners. Altogether we have treated so far fifty-four cases, among which three deaths have been reported.

From our clinical trials it has been observed that polyporin controls the temperature within a very short time and it lessens the toxicity and prevents complications like tympanites, diarrhœa, etc., which are the terror of typhoid cases. It is also indicated in hæmorrhage cases. It has been further observed that if polyporin treatment is commenced early, that is, on the third or fourth day of the attack, it cuts short the usual period.

Dosage. As already stated, polyporin is neither destroyed nor loses its potency when it comes in contact with gastric juices. Hence it is being administered by oral route. The dosage has been determined arbitrarily; one ampoule (containing 3 c.c. of crude polyporin) is given every four hours. It has been observed clinically that if polyporin is administered in an empty stomach, it gives better results.

Duration of treatment. The duration of treatment will depend upon the severity of the case. It has been observed that it requires seven to ten days for complete recovery. Our usual practice is to continue polyporin for three or four days after the total disappearance of signs and symptoms in order to avoid relapse.

In connexion with typhoid cases it may be mentioned that localized abscesses, such as sub-diaphragmatic abscess caused by typhoid organisms, respond well to crude polyporin by local application.

Chemical Investigation

Chemical investigation of the crude filtrate (polyporin) has been carried out by Prof. N. K. Sen, professor of chemistry, Presidency College, Calcutta. The results of his investigation are appended below.

During the growth of the fungus in the culture medium—a modified Czapek-Dox solution—the original colourless liquid became yellow and finally orange yellow or brown. In some cultures the medium was dark brown in colour and had a somewhat musty odour. There was no smell of ammonia. So, with a view to ascertaining the chemical nature of the antibiotic, the active culture fluid was subjected to the following treatments.

Effect of heat. 200 c.c. of the culture fluid having *p*H 5·8 and giving a zone of 15 mm. against typhoid bacillus was filtered through absorbent cotton and the mycelium squeezed out.

(*a*) 10 c.c. of the filtrate was heated to dryness on a water-bath for six hours. A sticky brown mass was obtained, which was dried in a steam-oven for eight hours. The residue, when tested in aqueous solution, gave an increased activity against typhoid bacillus (19 mm. zone with *p*H 5·4).

(*b*) The remaining sparkling orange-yellow filtrate was distilled under reduced pressure at 60–65° C. The distillate gave *p*H 6·5 with no activity. The brown syrupy residue in the distilling flask had a *p*H 5·5. It was found to be strongly active against typhoid bacillus, producing a lytic zone of 25 mm. by the agar-cup method.

150 c.c. of the distillate was collected, which gave negative tests with Nessler's reagent, Schiff's reagent, Fehling's solution and with alkaline iodine in potassium iodide, showing the absence of free ammonia, reducing substances such as aldehydes and ketones, and alcohols in the distillate.

Effect of heat with steam. (*A*) In alkaline solution. 200 c.c. of the active culture fluid having a *p*H 6·4 with a zone of 14 mm. against typhoid bacillus was made alkaline when the colour of the medium changed to dirty green. The mixture was then subjected to steam distillation and about 150 c.c. of colourless distillate was obtained, which showed the following properties: (1) *p*H, 6·0; (2) no activity against typhoid bacillus; (3) it gave a faint musty smell; (4) the distillate slightly reduced Fehling's solution, ammoniacal silver nitrate and potassium permanganate, indicating the presence of reducing substances in the distillate; (5) it gave a positive iodoform reaction showing the presence of alcohol or bodies containing —CH_2CO— group; (6) Schiff's reagent for aldehydes gave negative result; (7) the presence of amines by carbylamine test could not be shown; (8) with Nessler's reagent a yellow precipitate gradually formed, showing the presence of combined ammonium salts in the original fluid.

(*B*) In acid solution. The alkaline residue after steam distillation was acidified with syrupy phosphoric acid when the colour became reddish-brown and steam distillation was continued. 300 c.c. of the distillate was collected which gave a negative test for phosphoric acid. The distillate and the residue in the flask after neutralization showed no activity against typhoid bacillus. The barium salt obtained from the distillate on neutralization with baryta water was of yellow colour and yielded a mixture of fatty acids on decomposition by sulphuric acid and subsequent extraction with ether.

Concentration

In order to obtain more definite evidence about the chemical nature of the antibiotic substance, 525 c.c. of a light-yellow-coloured culture fluid with *p*H 7·0 and having a slight activity (a 14 mm. zone against typhoid bacillus) was first concentrated by the freezing and thawing method of Challinor and MacNaughtan[14], from which 225 c.c. of an orange-yellow-coloured liquid with *p*H 5·4 was first separated. It gave a greater activity against typhoid bacillus (a 19 mm. zone) than the original fluid. The deep-coloured concentrated solution was purified by chromatography by passing the solution through a column of Brockmann's alumina which adsorbed the red colouring matter. The sparkling yellow filtrate

THE CHOLERA PLATE, AGAR-CUP METHOD. THE ZONE IN THE SIDE REPRESENTS THE 29 MM. LYTIC ZONE OF POLYPORIN IN THE CUP, AND THE 20 MM. ZONE AT THE CENTRE IS OF 0·5 PER CENT MERCURIC CHLORIDE IN THE CUP, USED AS STANDARD IN EVERY PLATE

from the chromatogram practically retained the activity intact (an 18 mm. zone against typhoid bacillus). This was further concentrated under reduced pressure in an atmosphere of an inert gas. The syrupy liquid possessing increasing activity (a 25 mm. zone) was stirred with purified quartz sand and dried over concentrated sulphuric acid in a vacuum desiccator. The dried mass was extracted successively with dry ether, chloroform, ethyl acetate, absolute alcohol and acetone in a Soxhlet apparatus.

A. (1) *Ethereal extract.* The ethereal extract yielded a brown residue which in aqueous solution gave *p*H 5·5 and an increased activity against typhoid bacillus with a lytic zone (31 mm.) by the agar-cup method and gave a negative test for sugar. The aqueous solution of the antibiotic when autoclaved gave a lytic zone of 18 mm. against typhoid bacillus and a lytic zone of 29 mm. against cholera (see accompanying illustration).

(2) *Chloroform extract.* The light-yellow-coloured chloroform extract on evaporation under reduced pressure yielded a syrupy residue which on treatment with water gave a yellow-coloured solution and a brown insoluble sticky mass containing the colouring matter of the original culture fluid. The yellow aqueous solution when put to anti-test gave a lytic zone of 12 mm. against typhoid bacillus.

(3) *Ethyl-acetate extract.* The ethyl-acetate extract yielded a brown syrupy residue on evaporation. The syrup dissolved in water with a reddish-brown colour and gave a clear zone of 20 mm. against typhoid bacillus, 26 mm. against para-typhoid *A*, 21 mm. against para-typhoid *B*, 16 mm. against flexner, and 19 mm. against *B. coli.* It reduced Fehling's solution, showing the presence of reducing sugars.

(4) *Absolute alcohol extract.* The absolute alcohol extract yielded a yellowish-white sticky mass which dissolved in water with a yellow colour and gave a clear zone of 19 mm. against typhoid bacillus. The sticky mass did not solidify when kept over concentrated sulphuric acid in a vacuum desiccator for a long time.

(5) *Acetone extract.* The acetone extract on evaporation under reduced pressure deposited a white waxy mass insoluble in water, possessing no activity against typhoid bacillus.

(6) The residue left after extraction with acetone gave a slight activity when tested in aqueous solution against typhoid bacillus.

B. The sodium salt of the antibiotic was obtained from the original active culture fluid by the method of Berger[15]. The salt retained its activity against typhoid and cholera bacilli for a long time.

From the foregoing experiments it has been found that the active substance is thermostable and non-volatile, but it is destroyed on prolonged heating with steam at 100° C. in presence of alkali and acid. It is acidic in nature and fairly soluble in dry ether. The substance has not yet been obtained in a crystalline form.

Further investigation to isolate the antibiotic in a purer form from the ether extract of the purified and concentrated culture fluid is in progress.

In conclusion, I am grateful to the Indian Health Institute and Laboratories Ltd., of Beliaghata, Calcutta for helping me with two medical assistants, Mr. K. L. De and Mr. P. Ghosal, and one chemical assistant, Mr. Promode R. Banerjee, and for financing this research from the very beginning. I regret that more in the way of facilities has not been available for the quick and satisfactory progress of this work.

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THE VELOCITY OF SOUND: A MOLECULAR PROPERTY

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THE classical conception of the mechanism of the propagation of sound in gases presents two alternative expressions for the velocity, according as one assumes with Newton that the elastic processes are isothermal, or with Laplace that they are adiabatic. It is well known that experiments show the latter to be appropriate down to the lowest frequencies at which measurements have been made. The ratio of specific heats at constant pressure and constant volume respectively is characteristic of the molecules of a gas, and for this reason was much sought by Kundt and later experimenters on the velocity of sound in gases contained in tubes. Since the advent of convenient sources of high-frequency sound waves (supersonics) in the past twenty years, results have come to light which show that the ratio of specific heats may not be constant at all frequencies of vibration. Thus, Pierce[1] in 1925 found that the velocity of sound in carbon dioxide rose at a frequency in the neighbourhood of 100 kc./sec. by about 5 per cent. The effect has since been confirmed for other—mostly triatomic—gases, little change being noted in diatomic gases at ordinary temperatures up to the upper limit of frequency (about 5 megacycles per second) as yet attained.

An explanation of these results was put forward in its essential form by Herzfeld and Rice[2] in 1928 in what is known as the 'relaxation theory', although this theory goes commonly under the name of Kneser. In this theory it is supposed that the energy passed on through a system of molecules begins as translational, so that each one gets a pull or push in the direction of propagation of the waves, but that the molecules begin to convert this external energy of translation into internal vibrations (or rotations), like a train of railway wagons impelled by a locomotive, before passing it on. At low frequencies, the compressions follow each other more slowly than these 'relaxations' can take place; but when they succeed each other more rapidly than the molecules can convert the energy into internal energy, the molecules pass it on with less delay, so that the speed with which the sound wave passes through the system increases. The form of the variation of velocity with frequency envisaged by this theory—two level lines

connected by a short upcast at the critical frequency —is exactly like that predicted by Debye's relaxation theory for dielectric constants at high frequency. At the same time, this relaxation upsets the phase relationship between particle velocity and pressure in the sound wave, and this in turn is apparent as an enhanced absorption of the sound.

Besides the limited number of pure gases in which this effect has been noted, quite a number of gases which otherwise behave normally show changes of velocity with frequency if they are mixed with a small quantity of a 'catalyst'; such, for example, is oxygen mixed with a small quantity of water vapour.

If we increase or reduce the pressure on a gas, we increase or reduce the frequency of collisions on which the conversion from translational to vibrational energy depends, and so push the dispersion region higher up the scale of frequency. Increase of temperature can also do this, but any relaxation effect that ensues has to be carefully sorted out from the ordinary rise of velocity of sound with temperature due to the reduction in density of the gas.

It should be noted that the hypothesis here outlined is a purely *a posteriori* one. The mean time of relaxation of a molecule on this hypothesis can be calculated if the frequency at which the change-over from low-frequency velocity to high-frequency velocity is measured experimentally, but there is no independent experimental approach to the problem as yet—and in only one case has the relaxation time been calculated *a priori*. The problem of calculating the time of relaxation for simple molecules considered as harmonic oscillators is to find the number of collisions necessary, on the average, to produce an augmentation of the vibrational or rotational energies at the expense of the translational. As this augmentation can only take place by discontinuous jumps and requires more energy of translation than the molecules may possess individually, each collision is not effective; but one can calculate the percentage of molecules having the requisite velocity bearing in mind the type of collision—end-on, broadside, etc.—required to produce a vibration or rotation as the case may be. Van Paemel and Mariens[3] have thus found for the latter transformation mean times of 2×10^{-6} sec. for oxygen and $1{\cdot}3 \times 10^{-9}$ and $6{\cdot}6 \times 10^{-10}$ sec. for hydrogen and deuterium respectively at N.T.P. Although one experimental result corroborates the former value, most workers have failed to record any dispersion of the velocity of sound in oxygen, while the other two frequencies lie too high at present for certain experimental confirmation.

The possibility of influencing the molecules to react specifically to high-frequency sound by the addition of catalysts has already been mentioned. Other experimenters have tried to 'excite' the molecule by physical means. Dwyer[4] applied an electric shock to the iodine molecule by passing a discharge through the vapour; Van Itterbeek and Thys[5], a magnetic field to oxygen and nitric oxide; while I myself sought[6] for a change in the acoustic dispersion of carbon dioxide when irradiated with infra-red rays at one of its natural (optical) frequencies. None of these means of excitation can as yet be claimed to have effected its object, although the Belgian workers say that the *absorption* of sound waves in oxygen is increased in the presence of the magnetic field. (They found no change of velocity.) If some such effect were established it could be claimed as an indirect confirmation of the relaxation theory.

Turning to liquids, there is no evidence for dispersion of velocity—other than the steady fall with frequency which can be ascribed to the effect of friction at high frequencies. There is, nevertheless, strong absorption and some evidence for *scattering* of the sound waves out of the direct beam. (It will be appreciated that, with high-frequency sound waves, it is impossible to get a forthright beam in the sense that one does commonly in light, because the radiating face from which the sound streams cannot, in laboratory experiments in any event, be made very large compared to the wave-length. The scattering referred to is deviation in excess of that predicted by classical diffraction theory.) Such scattering has been ascribed either to the quasi-crystalline structure of a liquid, as postulated by Debye and others, or to the interaction between the sound and the thermal waves of casual origin which throng a liquid medium and give rise to a rapidly changing pattern of density fluctuations which then act as scattering centres. Attempts by Yvon[7] and others to relate the scattering to these thermal waves have so far led to little result of use owing to the indeterminacy of the wave-length of the thermal 'modulations' of the sound waves. It is noteworthy that liquids in which this acoustical anisotropy is most marked are just those, like benzene and xylene, in which the effects of optical anisotropy are commonly demonstrated.

A generalization, which is at present unsubstantiated by theory, was pointed out by M. R. Rao[8] between the velocities of sound (v) in liquid members of homologous series and the molecular weight (M) and density (d). He found in fact that $v^{1/3}\, M/d$ was a constant throughout such a series. Lagemann and Dunbar[9] have tested this parameter, which they call the 'molecular velocity of sound'—though mark that it has not the dimensions of a velocity—against other physical properties of the members of the series such as viscosity, surface tension, Van der Waals' constant, etc., and found linear relationships between it and other parameters involving these quantities. One feels, however, that such relationships in the absence of theoretical backing are too facile to set up.

Finally, what is the effect in vapours, especially near the critical point? No marked change of velocity with frequency has been reported, but some recently discovered peculiar effects in liquid helium require further discussion. Groenewald[10] pointed out in 1939 that owing to the high thermal conductivity of helium II, it might be expected to propagate sound under isothermal rather than adiabatic conditions. However, as the ratio of specific heats in helium is nearly unity, this would probably escape experimental observation. But there is another consequence of the high conductivity, for whereas in ordinary fluid, waves of temperature, if set up, are propagated at a very low velocity and are highly damped, in this peculiar medium they compare in velocity and persistence with the compressional waves. (To a first approximation, the speed of thermal waves of frequency f in a medium of thermal diffusivity k is $(4\pi kf)^{1/2}$ and the damping coefficient $(\pi f/k)^{1/2}$.) Such thermal waves might be set up in the compressions sent out by a conventional sound source, but they can best be studied by using an *ad hoc* source such as a metal plate in which an oscillatory temperature change is set up.

Such a source is a platinum strip to which alternating current is fed and is known in Great Britain as a 'thermophone', the invention of an engineer

named De Lange. In an ordinary fluid it sends out both thermal waves and sound (compressional) waves in virtue of the expansions and contractions of the fluid in its vicinity, but the former vanish in a few millimetres, leaving the sound waves which are radiated into the fluid in the normal way. (The frequency of these is double that of the alternating current supply.) In a fluid of great conductivity, the thermal waves should be appreciable to a much greater distance, and the true sound waves might be of less significance as local expansions and contractions of the fluid would be more difficult to set up; moreover, the latter would be of isothermal type. Peshkov[11] has made experiments with such a source in liquid helium near the λ-point using a resistance thermometer to plot out the thermal waves. His results indicate for the liquid a thermal diffusivity of order 10^3. He himself, following Landau[12], who in other respects is in agreement with Groenewald's ideas, ascribes this radiation to a special type of sound propagation called "the second velocity of sound in He II", associated with its abnormal fluidity; but it appears to me that no special property of the fluid is necessary to explain Peshkov's results other than that of superconductivity.

It is hoped that this résumé of recent work suffices to indicate the new avenues of approach to molecular physics which are opened up by measurements of the velocity of sound. Measurements of absorption, too, are of value, but their usefulness is limited by the need to sort out the absorption from the effects of diffraction.

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THE UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANISATION

THE progress report on the programme of the United Nations Educational, Scientific and Cultural Organisation, submitted to the Preparatory Commission at its fifth session opening on July 5, embodies the preliminary recommendations of the Secretariat and includes summaries of reports from the seven sectional committees. It is emphasized that U.N.E.S.C.O. will be principally concerned with the international aspects and implications of such questions and problems as lie within its domain, and that wherever possible it will work in collaboration with existing international organisations but will develop an active programme to supplement the work of other organisations. One of its prime tasks will be to promote the sciences and arts for their own sake, and their applications for the sake of human welfare. As regards science and knowledge, this will best be done by increasing and unifying the total volume of work, and in particular by bringing activity in the less-advanced areas towards the level of the more advanced. Another main aim is the encouragement of education and the free flow of information across national frontiers. In all fields freedom of research, information, opinion and education should be encouraged, and the approach must be world-wide.

In a general outline and synthesis of the proposed projects and activities of the Organisation, it is suggested that in addition to establishing effective working relations with other agencies of the United Nations and such bodies as the International Council of Scientific Unions, International Broadcasting Union, the Confederation of Authors' and Composers' Societies, it is suggested that U.N.E.S.C.O. should initiate the establishment of new international agencies such, for example, as an Association for Adult Education, a Microfilm Documentation Organisation, a Publications Clearing House, to supplement or continue the work of the Inter-Allied Book Centre and the American Book Centre, a Union of Engineering Associations and Federation of Film Archives. The establishment of regional offices throughout the world is also proposed, such offices to be housed in the same buildings as other United Nations organisations and agencies. Within its structure U.N.E.S.C.O. should maintain a library, archives and information service, with special collections of publications, films, recordings and other material to serve its various programmes. The library and information service should also assist in the preparation and distribution of bibliographies, abstracts, reading lists and reports, as well as promote the distribution and exchange of all U.N.E.S.C.O. publications. In addition, the report suggests the establishment of a world library centre, a world museography library and a scientific apparatus information bureau for the standardization of scientific equipment and the collection and dissemination of information and technical data relating to such equipment.

Studies and surveys which it is considered the Secretariat of the Organisation could well undertake itself with the aid of experts invited for the purpose include an inventory of the world's resources for research and study at the level of higher education, as suggested by the Natural Sciences and the Social Sciences Committee. The Natural Sciences Committee also proposes a study of the rationalization of the present system of publication of scientific journals, including abstracting and reviewing services, while the Social Sciences Committee proposes studies of the effects of mechanization upon civilization and of methods of facilitating international understanding and a report on public opinion surveys. Methods of operating, financing and staffing national library services are suggested for survey by the Libraries and Museums Committee, while the Education Committee advocates study of proposals for a world university and analyses of text-books, especially in history, geography and civics, to improve their international character. It is also suggested by the Social Sciences Committee that U.N.E.S.C.O. should set up under its auspices special institutes or commissions to survey home and community planning and to report on the use and misuse of modern psychology as a political technique. The Media of Mass Communication Committee would handle studies on mass communication in a like manner, while it is also suggested that U.N.E.S.C.O. should encourage or invite other international organisations or agencies to co-operate in examining the standardization of

scientific terms and equipment, library classification, bibliographic technique and publication sizes and format, as well as studies on nationalization and internationalism and population and racial problems.

In addition to this the various committees propose that U.N.E.S.C.O. should promote, encourage or undertake certain publications. The Education Committee suggests an International Education Journal and an International Education Yearbook, the Natural Sciences Committee suggests abstracting and reviewing journals in fields not adequately covered at present, summaries of scientific data, tables and handbooks, and popular publications on the international implications of science; and the Social Sciences Committee, a handbook of Social Science Research Organisations; a Yearbook of the Social Sciences, a Monthly Bulletin of the Social Sciences, which should include selected abstracts and bibliographies and popular publications on topics of world interest. Publications proposed by the Libraries and Museums Committee include a Directory of Science and Learning, covering all fields, and including information on available apparatus and facilities as well as personnel, other world reference books, such as Europa and Minerva, multi-lingual dictionaries and lexica of scientific and technical terms, an Annual Directory of Museums and Galleries, an International Museums Journal and Abstracts. It is also proposed by the Social Sciences Committee that U.N.E.S.C.O. should create a Study Centre in International Relations to be attended by graduates selected from all countries.

In addition to encouraging and furthering the national exchange of publications, films, scientific equipment and apparatus, etc., it is proposed that U.N.E.S.C.O. should, at the earliest possible date, summon international conferences on copyright and on International Relations in Institutes of Higher Learning. It is assumed that the former Conference will recommend an international agreement on copyright, while it is proposed that international agreements on the exchange of educational and documentary films and on postal and telecommunication rates will be recommended as early as possible. Institution of a system of grants-in-aid for both institutions and individuals, including research and sample and pilot projects, are among the numerous other activities proposed for U.N.E.S.C.O., while among the concrete pilot projects which U.N.E.S.C.O. could undertake to demonstrate its character and to open up unexplored fields the Natural Sciences Committee suggests outlines of text-books for a course in general science suitable for general cultival education, a U.N.E.S.C.O. Astronomical Observatory and a Meteorological Station in the Southern Hemisphere, a Centre of Applied Mathematics, for example, in India or China, a Nutritional Laboratory and an Institute for the study of problems in the equatorial forest belt. Special attention to the interchange of students, teachers and other professional workers is recommended by the Education Committee, while the Natural Sciences Committee regards the speeding up of the work of scientific rehabilitation as the most urgent problem of the moment. This Committee's report stresses the need to support and extend the work of the International Scientific Unions and in regard to the movement of men of science suggests the issue of some kind of identity card, recognized by all nations, as certifying the holder to be an accredited man of science, travelling on genuine scientific business.

NEWS and VIEWS

Geology at Glasgow: Prof. A. E. Trueman, F.R.S.

Prof. A. E. Trueman, professor of geology in the University of Glasgow, whose appointment as deputy chairman of the University Grants Committee has recently been announced, is a graduate of University College, Nottingham. He has been successively professor of geology at University College, Swansea (1920–33), the University of Bristol (1933–37), and the University of Glasgow (1937–46). His earlier researches on the evolution and variation of many fossil invertebrates from the Liassic rocks formed a good preparation for his most important work, which deals with the non-marine Lamellibranchs and zonal stratigraphy of the Coal Measures. The variation of these fossil shells was studied with a keen eye to detail and a philosophic insight which has led to the establishment of a fluid but precise nomenclature. In the hands of Prof. Trueman and his co-workers the non-marine Lamellibranchs have become of extreme economic importance in the correlation of seams in British and Continental coalfields. This work has been particularly valuable during the War, when Prof. Trueman's specialized knowledge was ever at the service of the Geological Survey. In collaboration with Dr. J. Weir he is writing a monograph on these shells, now in course of publication by the Palæontographical Society.

Apart from these research activities, Prof. Trueman has much experience of administrative work, and has taken a prominent part in the spreading of scientific knowledge and in the field of higher education. He has been a member of the Geological Survey Board for a number of years, and recently succeeded Sir Franklin Sibly as chairman. As secretary of the British Association Committee on the Teaching of Geology in Schools he has attempted to introduce geology to a wider audience, a purpose also served by his two books "The Scenery of England and Wales" and "An Introduction to Geology". As a member of the Elliot Commission (1943–4) he took an active interest in the problems of higher education in West Africa, and he has been a popular and successful president of the Geological Society since 1945. Prof. Trueman was awarded the Gold Medal of the South Wales Institute of Engineers in 1934, and the Bigsby Medal of the Geological Society in 1939.

Prof. Thomas N. George

Prof. Thomas N. George has been appointed to succeed Prof. A. E. Trueman for a second time. After graduating in the University of Wales and at Cambridge, and then working for three years on the Geological Survey of Great Britain, Dr. George in 1933 succeeded Trueman as professor of geology and head of the Departments of Geology and Geography

at University College, Swansea. Much of his work relates to the carboniferous limestone of South Wales, where he has mapped extensive areas and revealed structural information of great interest in relation to the folding of the limestones. In connexion with these studies he has investigated carboniferous fossils, and especially the brachiopods and goniatites. He has made considerable contributions to the geomorphology of Wales, and his studies of river development have been of great interest. Work on glacial deposits, on raised-beach and cave deposits, and on more general geological problems indicates the wide range of his interests. Prof. George has also been active in university administration and in various branches of adult educational work.

Chemistry at Birmingham

A SECOND chair has been established in the Department of Chemistry in the University of Birmingham and Dr. Maurice Stacey, at present reader in biological chemistry, has been appointed to it. Dr. Stacey graduated at Birmingham in 1929 and engaged in carbohydrate research work under Prof. W. N. Haworth. He obtained his Ph.D. degree in 1932 and in the following year was awarded the Meldola Medal mainly for his work with Haworth and Hirst on the synthesis of vitamin C. In the same year he gained a Beit Memorial fellowship for medical research, which he held at the London School of Hygiene and Tropical Medicine under Prof. H. Raistrick. Here he worked on the structure of complex carbohydrates produced by moulds and on the immunochemistry of bacteria in the typhoid group. In 1936 he rejoined Prof. W. N. Haworth's staff at Birmingham as lecturer and in 1937 spent some time with Prof. M. Heidelberger at Columbia University Medical School, New York. He was awarded his D.Sc. in 1939. For some years Dr. Stacey has directed a team of research workers engaged in studying the chemistry of micro-organisms and recently has made important advances in this field. Since 1940 he has been leader of Prof. W. N. Haworth's large group engaged in problems connected with the chemical side of the atomic energy project. Dr. Stacey was a member of the Tube Alloys Chemical and other Panels and is a member of council of the Chemical Society and a fellow of the Royal Institute of Chemistry.

Dr. Fred Smith, who is returning to the department in October after spending two and a half years on the atomic energy project and at the University of Minnesota, has been promoted to a senior lectureship in the University. Dr. E. J. Bourne has been appointed to a lectureship. Dr. M. Webb has been appointed to an Imperial Chemical Industries fellowship. Dr. F. H. Newth and Mr. P. W. Kent have been appointed assistant lecturers. Mr. J. Read and Dr. G. A. Gilbert, Imperial Chemical Industries fellows, are shortly going to the United States to engage in research work.

European Archæology at Oxford : C. F. C. Hawkes

MR. CHRISTOPHER F. C. HAWKES, the first holder of the new chair of European archæology at Oxford, is one of the most active among the younger prehistorians. He was a scholar of Winchester and of New College, and entered the British Museum shortly after taking his degree in the Honour School of Literæ Humaniores. While still an undergraduate, he took part in the excavation of the entrenched camp on St. Catharine's Hill, and later conducted a series of excavations at Colchester (Roman *Camulodunum*), the results of which have been published recently. In 1932 he was a secretary of the International Congress of Prehistoric and Protohistoric Sciences in London, and published with W. T. D. Kendrick a retrospect of "Archæology in England and Wales, 1914–1931". Mr. Hawkes is a fellow of the Society of Antiquaries and an active member of the Royal Anthropological Institute and the Archæological Institute. His principal publication is "The Prehistoric Foundations of Europe" (Methuen, 1940). In his excavations and other field work, Mr. Hawkes has shown himself an inspiring leader and teacher, and at Oxford he will have every encouragement to build up a strong school of prehistoric archæology.

Presentation to Prof. E. K. Rideal, F.R.S.

IT was announced in *Nature* for December 25, 1945, that Prof. E. K. Rideal, professor of colloid science in the University of Cambridge, had been appointed Fullerian Professor at the Royal Institution and director of the Davy Faraday Laboratory as from next October. Recently the Department of Colloid Science issued invitations to all its members past and present, and to all those who had been associated with Prof. Rideal as collaborators in research, to a presentation dinner. This took place in Trinity Hall, Cambridge, on July 6, and nearly ninety people attended from all over the British Isles as well as a few from overseas. To mark this occasion a bibliography was prepared of all the original scientific works achieved under Prof. Rideal's direction or in association with him over a period of some thirty-five years. A copy was presented to Prof. Rideal and to all subscribing members. The book has some five hundred and fifty references of original work, and emphasizes Prof. Rideal's great activity in building up the School of Colloid Science in the University of Cambridge. We feel sure that the cordial good wishes of many who were unable to attend this function will go with Prof. Rideal in his new appointment.

Commemoration of Alexander Samoilov

A CONFERENCE dedicated to the memory of the eminent physiologist Prof. Alexander Samoilov took place recently in the University of Moscow on the occasion of the fifteenth anniversary of his death in 1930. Prof. Samoilov, who was responsible for important advances in the physiology of the nervous system and in electrocardiography, was well known outside his country—in the United States, Great Britain and Holland, where he delivered speeches and lectures many times. Papers sent by E. D. Adrian (Cambridge), John F. Fulton (Yale) and Paul D. White (Boston, Mass.) were read at the conference. Speeches were also delivered by Ch. S. Koschtojanz, director of the Samoilov Laboratory of the University of Moscow and professor of physiology, and by Prof. V. Parin. The Institute of History of Natural Sciences of the Academy of Sciences of the U.S.S.R. organised in connexion with the conference an interesting exhibition of photographs portraying the life and works of Samoilov and his friendly and scientific relations with many celebrated physiologists of Europe and America. The Institute presented to each participant at the conference a reprint of the bibliography of the works of Prof. Samoilov.

New I.C.I. Laboratories for Fundamental Research

IMPERIAL CHEMICAL INDUSTRIES, LTD., have leased the house and laboratories at The Frythe, Welwyn, Herts, for long-term general and academic research in branches of biological, chemical and physical science. Among the subjects to be studied are the antibiotic products of moulds, kinetics of continuous chemical reactions and the deformation of materials under high stresses of short duration. Work will also be done on the design of industrial instruments and on industrial toxicology. The new laboratories will eventually house twenty or more senior research workers, with assistants and administrative staff. Some of the staff have already been recruited, but have hitherto been scattered in various localities while engaged on war-work. The premises at The Frythe are intended as temporary accommodation until a site at Butterwick Wood, near St. Albans, which was originally selected, can be developed. The activities of the Butterwick Research Laboratories will be completely independent of all other I.C.I. research departments, which will continue to be concerned with more specifically industrial problems.

Colour Receptors in the Human Fovea

DR. F. W. EDRIDGE-GREEN suggests that, if Prof. Hartridge's observations in *Nature* of July 20 were correct, the stars should appear to change colour as their light falls upon different cones of the fovea. Prof. Hartridge, in reply, says "Dr. Edridge-Green is quite right. On either the three-colour theory of Thomas Young, or on its modern counterpart, the Wundt–Granit hypothesis, one would expect a point source, and therefore a star, to undergo subjective changes of colour as its image is caused to move over the retina. Some stars do change colour, a fact usually explained on purely physical grounds; I have also noticed changes of colour of local sources under conditions where physical explanations did not appear to apply (*Nature*, July 20, p. 97). Why, it may be asked, are such colour variations so seldom seen when the eye is being used in normal vision? The answer is not a simple one, since many factors play a part. In the first place the retinal image, even of a point source, falls on a considerable area of retina. This is partly due to diffraction, and partly due to aberrations. In consequence, many photoreceptors are usually stimulated at the same time. But further, colours which would normally be seen are eliminated by the anti-chromatic responses. In the third place, there is a process which tends to smooth out differences in response. This is now under further investigation, because it is hindering progress. When a method has been found of putting this process temporarily out of action, a new avenue of approach to the essential problem of vision will probably have been found."

Catalogue of Huxley's Papers and Correspondence

IN 1937, through the good offices of the Friends of the National Libraries, the correspondence and papers of Thomas Henry Huxley were presented to the Imperial College of Science and Technology, London. During the War, these papers were necessarily inaccessible, but as soon as it became safe to bring them out of hiding, the governing body of the College decided that they should at once be made available, and the work of arranging and cataloguing them was entrusted to Mr. Warren R. Dawson, who has had much experience of work of this nature and has previously published catalogues of various collections of scientific papers such as the Smith manuscripts of the Linnean Society, and the entire manuscript collection of the Medical Society of London. The arrangement of the Huxley Papers has been accomplished, and a complete descriptive catalogue of the entire collection has been prepared; it will be published shortly by Messrs. Macmillan & Co., Ltd., St. Martin's Street, London, W.C.2. The collection comprises some five thousand letters, and a large mass of other papers covering the entire range of Huxley's manifold activities—biology, anthropology, education, philosophy, and many other subjects in which he interested himself, and upon which he left his mark. The catalogue should be of great value in the study of the history of science during a brilliant phase of its development.

Publication and Distribution of Scientific Papers

IN a paper presented before the American Association for the Advancement of Science at its Cleveland meeting on September 11, 1944, Zeliaette Troy, librarian of the Boyce Thompson Institute for Plant Research, reiterated earlier proposals for dealing with the mechanical side of the publication and distribution of scientific papers originally outlined in *Special Libraries* in July–August 1943. It is urged that the whole problem is purely a matter of good business management and should be considered factually. To centralize the printing of scientific papers and abstracts in one establishment covering all sciences and technologies—presumably, one for each country—would offer all the advantages of modern mass-production methods in the mechanical aspects such as paper and ink supplies, printing and indexing by specialists, apart from the comprehensive service which could be offered to any subscriber or reader in the field he designated. The central organisation is visualized as a limited company in which the shares are held by the various organisations interested in publishing and purchasing scientific and technical papers; original research articles and summary-review articles would be published and sold in much the same way as U.S. patent specifications, and the abstracts journal would be analogous to the *Official Patent Office Gazette*.

Industrial Development of Northern Rhodesia

THE first report of the Advisory Committee on Industrial Development, Northern Rhodesia (Lusaka: Government Printer, 1946. 1*s*.) recommends the renewal of a number of customs agreements as well as a clear statement of policy on the extent to which the African will be allowed to participate in semi-skilled or skilled labour, and the enactment of legislation to prevent dumping. The Committee recommends that the Government's undertaking to develop Ndola as the commercial and distributive centre of the Copperbelt be rescinded, and secondary industries be allowed to select any location convenient for them, including the four Copperbelt townships. It also welcomes the formation of a Statistical Department as visualized by the Central African Council, and in the meantime requires the services of a full-time technical officer. Of a number of agricultural products examined with a view to their processing or industrial utilization, cassava holds possibilities for the production of starch as a secondary industry. Evidence is against the successful establishment of a cotton-

growing industry, but there are a number of essential oils the development of which might repay close investigation, and further experiment on the cultivation of tung oil by the Agricultural Department is recommended. After a thorough examination of all phases of a cement factory in Northern Rhodesia, the Committee considers that the establishment of this industry holds little prospect of financial success unless a territorial consumption of 20,000 tons a year can be guaranteed for at least fifteen years. Complete information on the coal resources of the Territory is being assembled, and the manufacture of cycles and fibre board, and the formation of a central logging organisation have also received attention. Proposals are advanced for developing the tourist industry, and a memorandum has been submitted to the Government on the importance of increasing the existing power services. There are good technical and economic prospects for a small sheet metal industry to process utensils for African trade, and support is urged for the establishment of the fishing industry on a sound basis. Publication in booklet form of complete information on the mineral resources of Northern Rhodesia is recommended.

Safety of Malaysian Hepaticæ in Germany

THE Farlow Herbarium of Harvard University has received word that a valuable collection of more than three thousand specimens of Malaysian Hepaticæ, chiefly epiphytic Lejeuneaceæ gathered by Dr. Frans Verdoorn as well as some other collections assembled by him between 1925 and 1936, which were on loan, at the outbreak of the War, to the Botanical Institute of the University of Jena, is safe. Prof. Th. Herzog who, with a number of assistants and graduate students, is working on this collection writes that he placed most of it, during the early war years, for safeguarding in a country home near Jena. This house was almost entirely destroyed by a bomb; the specimens, however, were found in undamaged condition in the wreckage of the basement. They were later removed to a part of the basement at the Botanical Institute. This building and most of the basement were entirely destroyed at a later date when nine students were killed and the director, Prof. Renner, was seriously wounded. The bryological collections were fortunately in a wing where the basement withstood the bombing, and work on them is now being continued by Prof. Herzog and his assistants, Drs. Benedict and Schuchardt.

Sixth International Congress on Experimental Cell Research

THE Sixth International Congress on Experimental Cell Research is to be held in Stockholm in July 1947. The Congress will be organised by a Swedish working committee. Prof. J. Runnström of Wenner-Grens Institute will act as chairman for the Conference and Prof. T. Caspersson and Dr. H. Hyden of the Karolinska Institute as secretaries. A preliminary programme will be published at the beginning of the autumn. The Conference will include a series of symposia on important problems in experimental cell research from the physico-chemical, physiological and morphological aspects. The Swedish organising committee hopes that cell research workers of all kinds will take advantage of this occasion for exchanging experiences and renewing contact with their colleagues. Suggestions or questions regarding the Conference should be sent to the secretaries.

The Night Sky in September

FULL moon occurs on Sept. 11d. 09h. 59m. U.T. and new moon on Sept. 25d. 08h. 45m. The following conjunctions with the moon take place: Sept. 21d. 04h., Saturn 4° S.; Sept. 27d. 13h., Jupiter 3° S.; Sept. 27d. 16h., Mars 4° S.; Sept. 29d. 00h., Venus 7° S. In addition to these conjunctions with the moon, the following conjunctions occur: Sept. 4d. 03h., Venus in conjunction with Jupiter, Venus 3·5° S.; Sept. 25d. 04h., Mars in conjunction with Jupiter, Mars 1·1° S. There is an occultation of ν Pisc, reappearance taking place on Sept. 14d. 01h. 56·2m. Mercury rises about an hour before the sun on Sept. 1 and can be seen in the eastern sky. The planet is in conjunction with the sun on Sept. 14 and is not favourably placed for observation during the greater portion of the month. Venus sets an hour after the sun on Sept. 1 and 45 minutes after the sun on Sept. 30, attaining its greatest eastern elongation on Sept. 8. During the month the stellar magnitude of Venus varies from $-3·9$ to $-4·2$. Mars and Jupiter are unfavourably placed for observation. Saturn rises at 2h. on Sept. 1 and at 0h. 19m. on Sept. 30 and can be seen in the constellation of Cancer in the morning hours. Its stellar magnitude is 0·5 during the month. Autumn equinox occurs on Sept. 23d. 16h.

Announcements

UNDER the auspices of the Central University, Quito, Ecuador, a general scientific review covering pharmacy, chemistry, physics and biology has been published under the title *Revista de la Asociacion Escuela de Quimica y Farmacia*. The Director (University, Quito, Apartado No. 166) is anxious to keep in touch with scientific developments everywhere and requests exchanges with similar reviews in America and the Old World.

The Royal Society of New Zealand invites applications for the T. K. Sidey Summer Time Award of a bronze medal and a prize of £100. The award is made for scientific research on any kind of electromagnetic radiation (visible or invisible), including its relation to human welfare. Further information may be obtained from the Secretary, Royal Society of New Zealand, Victoria University College, Wellington, New Zealand.

THE report of proceedings of the twentieth conference of the Association of Special Libraries and Information Bureaux includes the papers presented at the Conference last September (see *Nature*, 156, 605; 1945) together with notes on the discussions and reports on the work of the ASLIB Microfilm Service and on the British Union Catalogue of Periodicals, and notes on the National Central Library and the Inter-Allied Book Centre. There is also a brief summary of a paper by Mr. E. Reid on the reform of the system of scientific publication by basing it on the individual paper as the unit. Charts displayed at the Conference showing the growth and distribution of the membership of the Association have been reproduced. Additions to the list of desk reference books given by Miss M. Bateman in her paper and suggested by members during the discussion are collected in a useful appendix to that paper.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fixation Area in the Human Eye

USING the micro-stimulation apparatus referred to in a recent communication, further experiments have now been performed with the object of elucidating the process of visual fixation. It was found that there was a small scotoma (blind spot) for red rays, which was situated in my own fovea, about seven cone units away from the fixation point for green rays. Since it is unlikely that this spot alters its position on the retina, successive determinations of the position of the fixation point for green rays, relative to this spot, enables any changes in the former to be detected. The fixation point for green rays (5,200 A.) was found in this way to be very constant in position (see Table 1).

TABLE 1. POSITION (IN CONE UNITS) IN VISUAL FIELD OF FIXATION POINT FOR GREEN RAYS, RELATIVE TO BLIND SPOT FOR RED RAYS

Series 1		Series 2		Series 3	
Above by	To right by	Above by	To right by	Above by	To right by
4·60 c.u.	1·00 c.u.	5·5 c.u.	0·8 c.u.	5·0 c.u.	1·4 c.u.
4·65 ,,	1·00 ,,	4·9 ,,	0·7 ,,	6·0 ,,	1·8 ,,
4·70 ,,	1·15 ,,	5·0 ,,	1·1 ,,	5·2 ,,	1·8 ,,
4·60 ,,	1·05 ,,	5 4 ,,	1·2 ,,	4·4 ,,	0·3 ,,
4·70 ,,	0·90 ,,	5·2 ,,	0·7 ,,	4·4 ,,	1·1 ,,
		5·5 ,,	0·6 ,,	5·7 ,,	0·2 ,,
		5·4 ,,	1·2 ,,	4·4 ,,	1·7 ,,
		4·8 ,,	1·3 ,,		
Means 4·65 ,,	1·20 ,,	Means 5·21 ,,	0·95 ,,	Means 5·01 ,,	1·18 ,,

The first series was made keeping the conditions as uniform as possible. During the second series, made the following evening, alterations were carried out in most parts of the apparatus, such as rotating the eyepiece, rotating the objective, replacing the mirror by a different one, etc. During the third series, made about a week later, alterations were made in the adaptation, and degree of accommodation of the eye, etc. It will be noticed that the green fixation point altered scarcely at all in position during the period covered by these tests.

The conclusion, from the above experiments, is that one particular retinal receptor is performing the function of fixation during the time that green rays are being used for visual purposes.

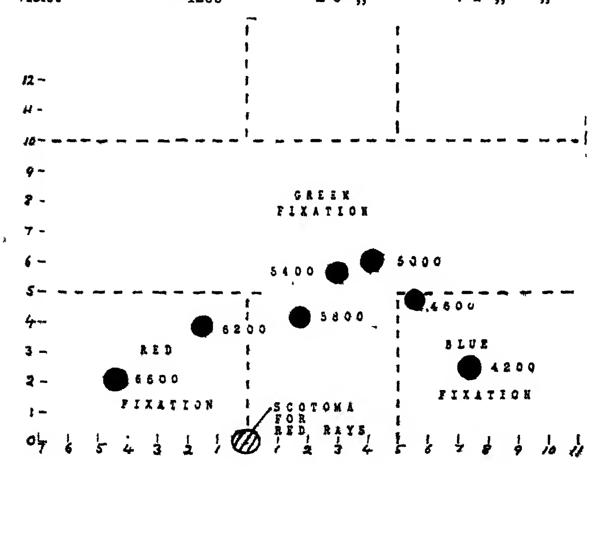
Experiments were now performed to determine the positions of the fixation points for other colours: red, orange, yellow, blue-green, blue and violet. The results, which are given in Table 2, are plotted in the accompanying chart.

It will be seen that the red and orange fixation points fall within what was called, in a previous communication, "the red fixation area". The yellow, green, and blue-green fixation points fall similarly within "the green fixation area". The violet fixation point lies within "the blue fixation area"; while the blue one is at the border of that area. Thus the results previously obtained are confirmed.

It seems very unlikely that the fixation points for a particular colour would occur in a region devoid of receptors of that colour. The converse was considered more likely. This points to the existence of clusters of sense organs of similar, or nearly similar, response, thus supporting the cluster hypothesis. The existence of all these different fixation points indicates the presence in the fovea of sense organs of all these different kinds, thus supporting Granit's hypothesis. Additional evidence has been obtained on this point, using the micro-stimulator, by causing a small colourless source to move slowly over the surface of the retina, when it was seen in the following colours: red, orange, green, pale blue-green, grey-blue. Red was sometimes seen as orange and as pale orange. Orange sometimes appeared red and sometimes very pale orange. Yellow appeared to be red, orange, green, and white. Green at times looked very pale green, occasionally it looked white. Blue looked pale blue-green, or grey. All the above colours are probably modified by the dichromatism, caused by the anti-chromatic responses.

TABLE 2

Fixation for	Wave-length	Vertically above by	Horizontally left or right by
Red	6600	2·1 c.u.	4·4 c.u. left
Orange	6200	3·9 ,,	1·5 ,, ,,
Yellow	5800	4·2 ,,	1·7 ,, right
Green	5400	5·7 ,,	3·0 ,, ,,
Blue-Green	5000	6·1 ,,	4·2 ,, ,,
Blue	4600	4·8 ,,	5·6 ,, ,,
Violet	4200	2·6 ,,	7·4 ,, ,,



The evidence in favour of the Wundt-Granit hypothesis is summarized in Table 3.

TABLE 3

Red	—	*F*	*M S.*	P_1	*R.D.*
Orange	*G*	*F*	*M.S.*	—	—
Yellow	*G*	*F*	—	P_2	*R.D.*
Green	*G*	*F*	*M.S.*	P_1	*R.D.*
Blue-Green	*G*	*F*	*M.S.*	—	—
Blue	*G*	*F*	*M.S.*	P_1	*R D.*
Violet	*G*	*F*	—	—	—

G = Granit's micro-electrode experiment on animals.
F = Author's fixation method.
M.S. = Author's micro-stimulation method.
P_1 = Primary colour on Young's trichromatic theory.
P_2 = Primary colour according to Hering, Donders and G. E. Müller.
R.D. = Retinal direction effect of Stiles and Crawford.

In Table 3 is summarized the evidence in favour of retinal receptors for the different colours mentioned, so far as it is known at present. Further experiments on these lines are in progress.

H. HARTRIDGE

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Medical College of St. Bartholomew's Hospital,
London, E.C.1.
July 29.

Concentration of Visual Purple in the Human Eye

ACCORDING to the measurements of v.d. Velden[1], the efficiency of the human retina is sometimes nearly 1; every quantum of light that reaches the retina is absorbed. Then it elicits a response of the sense cell[2,3]. An efficiency of 1 would mean that the density of the visual purple is large enough to cause a difference between the sensitivity curve of the dark-adapted eye and the absorption curve of visual purple; so long as a small amount of visual purple is present, the amount of light absorbed at various wave-lengths is proportional to the absorption coefficient. As soon as the density of visual purple is large enough, the absorption at the maximum (505 mμ) becomes relatively smaller. In the extreme case of very high density, the absorption is 100 per cent in a broad region of the spectrum, irrespective of the wave-length, and the maximum at 505 mμ is flattened out.

Therefore one might expect that if a blue (505 mμ) and a yellow field (580 mμ) seem equal to each other after a very short time of adaptation (some minutes), the blue field would become relatively darker than the yellow field after a sufficient time of adaptation. This is not the Purkinje effect, since it is in the opposite direction. (Of course, no colour is seen by the rods; here blue and yellow only refer to the wave-lengths.)

The experimental arrangement was as follows. A white sheet of paper was illuminated by light of the colour-mixing apparatus. The diameter of the test field was 10°; the central part of the field was dark (2°). One half of the field was illuminated by 505 mμ, one half by 580 mμ. An artificial pupil was used, the diameter of which was reduced after some time of adaptation in order to obtain a constant subjective brightness. In three series of experiments, adaptation was followed for three hours. After each series, the match for the light-adapted eye (but for rod vision) was determined again. The third series of measurements was carried out after a vitamin A diet, but the results did not vary.

No influence of adaptation on the match was found, whereas an effect of 5 per cent would have been detected. This means that the absorption of the visual purple was smaller than 10 per cent at 505 mμ. In order to rule out the possibility that the regeneration of visual purple took place in the first few minutes of adaptation, the match of blue and yellow was made within some minutes after light adaptation. This was repeated about ten times, but the match did not differ from the match after some hours of dark adaptation. It is not as yet clear how this result can be brought into line with the findings of v.d. Velden. It may be that the visual purple is more concentrated in some smaller areas. Perhaps it will be possible to find somebody who has more visual purple in the dark-adapted state. This would be very important, as it would give us a possibility of studying the amount of visual purple during dark and light adaptation.

S. Hecht[2] also arrives at the conclusion that the absorption of the visual purple is less than 20 per cent, by comparing the scotopic luminosity curve with the absorption curve of visual purple. Some corrections must be applied to the luminosity curve, however, and therefore the measurements reported here give a useful check on Hecht's results. Moreover, the method reported in this communication does not require complicated apparatus or accurate measurements of the energies of the two fields; and these fields may be obtained by coloured filters, so that the measurements can be repeated by a simple equipment.

HL. DE VRIES

Natuurkundig Laboratorium
der Rijks-Universiteit,
Groningen.
July 16.

[1] Velden, H. A. v.d., *Physica*, **11**, 179 (1944).
[2] Hecht, S., Shlaer, S., and Pirenne, M. H., *J. Gen. Physiol.*, **25**, 819 (1942).
[3] Vries, Hl. de, *Physica*, **10**, 553 (1943).

Ageing of Nerve Cells

THE human brain contains hundreds of different types of nerve cells of varying structures. Each type is found in a circumscribed area, and forms, either on its own or together with a few other types of nerve cells, a grey centre or 'griseum'. As a result of the aggregation of the representatives of one cell type in a circumscribed region, the task of following the life-history of that particular cell type under normal or pathogenic conditions becomes possible, or at least easier.

Most representatives of a cell-type mature, age or 'fall ill' simultaneously.

To a large extent, the time course and morphological features of ageing are different in each cell type. The ageing process or 'involution' of a cell is different from any other regressive process or 'degeneration' it may undergo, but degenerative processes may, of course, occur in combination with an involution.

The time of onset of ageing of different cell types is sufficiently determined to permit an average order or 'pattern' of ageing to be established. Thus the cells of the inferior olivary body age particularly early, those of the pons much later, the vital cells of the medulla oblongata very late.

The ageing process always leads to the death of the cell. If it occurs at an average (normal) time, it causes partial death of the brain through normal death of the cell type in question. If a person lives sufficiently long, partial death of the vital cells of the medulla causes his or her death as a normal phenomenon. This form of death is a rare occurrence, because death through disease usually terminates the individual life at an earlier stage.

Mutations may delay or accelerate ageing in general. Frequently, however, their effect is restricted to certain cell types. If their effect is thus strong but circumscribed, it produces the so-called 'systemic involutions'. An example is the premature ageing, in paralysis agitans, of the nerve cells which contain melanin.

External factors may also affect the process of ageing. Arteriosclerosis, temporary hypoxæmia, poisoning (for example, by carbon monoxide) and infections (as in the case of Parkinsonism after encephalitis) may lead to premature ageing.

Lastly, the degree of activity of a particular cell type has a great effect on its ageing process. Destruction of nerve cells which normally stimulate other ganglion cells causes premature ageing of those cells which now receive fewer impulses. After the destruction of the cells of the corpus striatum, for example, there occurs a trans-neural involution of the cells of the nucleus pallidus. On the other hand, involution is delayed not only by normal but also by such excessive activity of nerve cells as results in their hypertrophy. Accordingly, in particularly active individuals the ageing of certain ganglion cells is delayed.

In different cell types, the ageing process produces different counter-reactions. One such reaction is the increase in Nissl granules ('hypertigrosis'), produced by an augmented activity of the nucleolus; another a hyperchromatosis and pyknosis of the nucleus which has hitherto been wrongly interpreted as a degeneration. Another is probably the vacuolization regularly observed during the involution of ganglion cells containing melanin. These counter-measures are particularly conspicuous in active individuals.

It is well known that cell division rejuvenates the cell while it interrupts its work. Division of a nerve cell would, accordingly, temporarily suppress its readiness for action. More important still, division would, by distributing the cell processes between two cells, destroy the adaptation to the reception and emission of impulses produced by the cell's previous activity. Lastly, the correct halving of long processes, for example, of the axons of giant pyramidal cells which are about 1 m. long and about 10 μ thick, appears to be mechanically impossible. It is, for example, known that the fibroblasts of *Triton* which bear processes withdraw these before undergoing cell division. From a functional point of view, however, the long processes of certain nerve cells are essential for an increased integration. We may, therefore, interpret the cessation of nerve cell division during embryonic development as a biological progress useful for selection but achieved at the price of individual death. In the breeding of particularly active individuals lies a possibility of gradually delaying the time of normal cerebral death.

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Pattern of Recovery in Protein Deficiency

REPEATED plasma volume determinations on liberated Indian prisoners-of-war suffering from extreme protein insufficiency have shown that the constituents of the total circulating volume return to normal in a definite sequence. These patients had, at the time they were first studied, a normochromic macrocytic anæmia, a reduced body weight, a reduced serum total protein concentration, confined almost entirely to the albumin fraction, and hence a reduction in the albumin/globulin ratio, a slightly reduced plasma volume and, because of the low hæmatocrit, a significantly reduced blood volume. There was, therefore, a great reduction in the total circulating hæmoglobin and total circulating plasma protein. When the patients were given a diet rich in calories, proteins and vitamins, the above factors returned to normal according to a definite pattern. For the sake of ease of description, the recovery process has been divided into three stages. These are purely arbitrary, and may show considerable variation in their time relations.

Stage 1 (0–4 weeks) is characterized by the rapid rise in plasma volume to normal. During this period the body-weight falls as the œdema disappears and may then slowly rise. The blood-volume rises steadily, but at such a rate that, although the hæmoglobin concentration and the hæmatocrit falls, the total circulating hæmoglobin increases. Although the hæmoglobin concentration falls, the red blood corpuscle concentration usually increases, since at this time the patient's blood is rapidly becoming less macrocytic. The total circulating plasma protein increases, but, because of the rapid rise in plasma volume, the plasma protein concentration changes but little. More albumin is formed than globulin, so the albumin/globulin ratio increases slightly.

Stage 2 (2–12 weeks) is characterized by the rapid rise of both the blood volume and the total circulating plasma protein to normal. The plasma volume, which had attained normal values in Stage 1, increases rapidly to values well above normal. There is also a rapid increase in body-weight and in total circulating hæmoglobin, because both the hæmoglobin concentration, which fell in Stage 1, and the blood-volume are increasing rapidly. The total circulating albumin increases more rapidly than the globulin, but the latter does, however, reach figures in excess of normal. The albumin/globulin ratio continues to increase.

Stage 3 (8–16 weeks) is marked by the transition from Stage 2 to normal values. The plasma-volume, which rose to above normal in Stage 2, returns to normal, and the blood-volume, which had reached normal in Stage 2, remains there. The body-weight, the hæmoglobin concentration and the total circulating hæmoglobin all steadily rise. There is also a steady rise in the plasma protein concentration, but, because of the fall in plasma-volume, the total circulating plasma protein remains the same. There is, however, still a rise in the total circulating albumin, which is balanced by a corresponding fall in the total circulating globulin. This is reflected in the continued increase of the albumin/globulin ratio.

STAGES OF RECOVERY IN PROTEIN DEFICIENCY

	Stage 1 (0–4 weeks)	Stage 2 (2–12 weeks)	Stage 3 (8–16 weeks)
Body-weight.	Decreases.	Increases rapidly.	Increases to normal.
Plasma volume.	Increases rapidly to normal.	Increases rapidly to above normal.	Decreases to normal.
Blood volume.	Increases.	Increases to normal.	No change.
Hb. conc. and Hæmatocrit.	Decreases or no change.	Increases.	Increases to normal.
Total circulating Hb.	Increases.	Increases rapidly.	Increases to normal.
R.B.C. conc.	Increases slightly or no change.	Increases.	Increases to normal.
Plasma protein concentration.	No change or increases slightly.	Increases rapidly.	Increases slightly to normal.
Total circulating plasma protein.	Increases.	Increases very rapidly to normal.	No change.
Total circulating albumin.	Increases.	Increases rapidly.	Increases to normal.
Total circulating globulin.	Increases slightly to normal.	Increases to above normal.	Decreases to normal.
Albumin/globulin ratio.	Increases slightly.	Increases.	Increases to normal.

The above description, which is of necessity an over-simplification, is summarized in the accompanying table. Full details of these findings will be published elsewhere.

I am grateful to the Director of Medical Services, India, for permission to publish this report.

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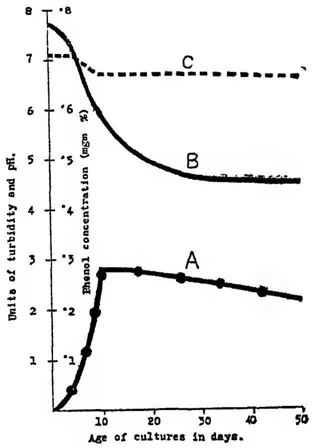
Utilization of Phenols and Related Compounds by *Achromobacter*

THE splitting of aromatic rings by certain bacteria, particularly soil bacteria, was observed many years ago, and has been described by various authors[1]. Some of these micro-organisms were growing on media in which the only source of carbon was aromatic hydrocarbons or phenols[2]. Hitherto the mechanism of the process, as well as the range of compounds decomposed by those bacteria described, have not been investigated carefully.

In our experiments we isolated from heavily manured soil certain strains of bacteria—*Achromobacter* type—the biological character of which did not differ from that of the standard types of these bacteria. All these strains were grown on inorganic phosphate medium (a modification of Grey and Thornton medium[3]) and phenol was added as the sole source of carbon. One of these strains was selected for more detailed experimentation.

Bacteria of this strain grew readily when 0·1 per cent phenol was used as the source of carbon, while the addition of 0·15 per cent prevented growth, but did not kill the bacteria until cultures were ten days old. The 0·2 per cent phenol exerted marked bactericidal activity in 48 hours. The aliphatic compounds (glucose, acetate, citrate) were a more convenient source of carbon for the selected strain and produced growth two to four times as abundant as the medium containing phenol. The curve representing the rate of growth on phenol was always reproducible, if the same conditions were main-



A. BACTERIAL GROWTH ESTIMATED NEPHELOMETRICALLY, EXPRESSED IN UNITS OF TURBIDITY. NEPHELOMETRIC ESTIMATIONS WERE CONTROLLED BY CELL COUNTING. *B.* PHENOL CONCENTRATION, ESTIMATED COLORIMETRICALLY ACCORDING TO FOLIN. *C.* *p*H OF CULTURE

tained. The rate of growth of bacteria in phenol depends on *p*H and reaches its peak at *p*H 7; at this *p*H also phenol disappears most rapidly (see chart).

The strain which has been described, while growing on medium containing 0·2 per cent of glucose and 0·1 per cent of phenol, used both substrates simultaneously. The increase in the number of bacteria was greater than in the case of phenol alone, and the disappearance of phenol markedly decreased.

Achromobacter exhibits high specificity in the utilization of different aromatics as the sole source of carbon. It cannot utilize unsubstituted aromatic hydrocarbons, since it does not grow on benzene or toluene when they are used in the media as free hydrocarbons or their sulphonic acids. The hydrogenation of the benzene ring makes it available to bacterial enzymes, as was shown in the case of cyclohexane, which is a good source of carbon. The introduction into the benzene ring of chlorine, nitro, amino or sulpho groups does not make the compounds available to the bacteria investigated; but the introduction of oxygen enables the benzene ring to be split.

Nearly all the mono-, di- and tri-phenols examined up to now (for example, phenol, *o*-, *m*- and *p*-cresols, catechol, resorcinol, 3,4-xylenol-1-ol, orcinol, pyrogallol) are good sources of carbon for such bacteria, and the essential factor is the presence of the free phenolic group. The phenolic ethers (anisol, phenetol, diphenyl-ether) are not attacked by this strain. The esters of phenol—sulphuric, acetic, benzoic—are readily utilized as the source of carbon. Most probably the enzymatic system of the bacterial cell contains esterases which split the ester linkage, and so render the free phenol available to the bacterial cell.

The introduction of oxygen makes the aromatic ring available for bacteria not only when it is present as a phenolic group, but also as an alcoholic group, for example, benzyl alcohol, or as a carboxyl group. The mono-carboxylic acids derived from benzene (for example, benzoic, phenyl-acetic, anthranilic, salicylic acids) produced even better bacterial growth than phenols. In this connexion it is curious that the two dicarboxylic acids examined, phthalic and terephthalic acids, are not attacked by these bacteria. The keto-derivatives benzophenon and benzil also were not utilized.

The ability to split the aromatic ring is limited to mono-cyclic compounds; all hydroxy and carboxy derivatives of naphthalene examined have failed to maintain bacterial growth when they are the sole source of carbon.

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Urease in the Gastric Mucosa and its Increase after a Meat Diet, Soya Bean Flour Diet or Urogastrone Injections

THERE is good reason for believing that gastric hydrochloric acid is neutralized by ammonia formed most probably by urease from circulating urea. This enzyme is present in the mucosa. This mechanism was first noted by Luck[1] and by Luck and Seth[2] in the dog and cat, and Linderstrøm-Lang and Ohlsen[3] noted also that in the dog the urease was most potent in the superficial rather than the deep mucosa. Furthermore, Linderstrøm-Lang and Ohlsen[3] held that urease was not present in all animals; for example, they held there was none present in the pig. From personal work we have shown that this ferment exists in at least man, dog, cat, rabbit, pig and rat. The amount in the first three species of animal appears to be much greater than in the latter three. Rigoni[4] had shown its presence in man, and, like Linderstrøm-Lang and Ohlsen, had speculated on its possible significance.

At room temperature as much as 66 mgm. ammonia nitrogen can be formed per hour from the total mucosa of a cat's stomach, this being sufficient ammonia to neutralize 47 ml. *N*/10 hydrochloric acid, far more acid than is formed by any cat's stomach in that time. We know that this quantity of ammonia is not released into the stomach (except, perhaps, in disease) so presumably the ammonia - hydrochloric acid reaction occurs intracellularly. There is some increase in intragastric ammonia coincidental with neutralization in both man and the cat at any rate, but not at all enough to explain the observed degree of neutralization. The urease seems to be present in largest amounts in the fundus, less in the pylorus and very little indeed in the duodenum or small intestine proper (cf. Table 1).

TABLE 1. AMMONIA NITROGEN (MGM.) RELEASED FROM UREA PER GRAM OF DRIED MUCOSA PER HOUR AT ROOM TEMPERATURE FROM CATS FED ONLY ON MILK AND FROM CATS FED ON MILK PLUS EXCESS MEAT IN THE FORM OF LUNGS AND LIVER. FIGURES IN BRACKETS SHOW NUMBER OF ANIMALS USED

	Sup. upper stomach	Deep upper stomach	Sup lower stomach	Deep lower stomach	Sup. duo-denum	Deep duo-denum
Milk fed	4·03 (7)	1·99 (8)	4 43 (8)	0·47 (8)	0·26 (5)	0·30 (5)
Meat fed	16·25 (15)	17·31 (15)	11·94 (14)	16·86 (14)	0·18 (11)	0·31 (11)

The amount of urease which is present varies from species to species, as has been noted above; but inside the same species the concentration of mucosal urease can be increased by any one of the three following methods: by high protein diet, by soya bean flour diet or by injections of concentrated pregnancy urine. Of the first of these, experiments in cats have shown that if an animal be placed on a high protein diet, it accumulates a far higher concentration of urease at the end of as little as a week, compared with the animal placed on a milk diet (cf. Table 1). It will be noted from the table that the concentration increase is quite definite and that apparently this increase in concentration is more remarkable in the deeper part of the mucosa of the stomach, both upper and lower, than it is in the superficial. The effect on the duodenal content of urease seems to be negligible.

TABLE 2. AMMONIA NITROGEN (MGM.) RELEASED PER GRAM PER HOUR FROM DRIED GASTRIC MUCOSA OF RATS INCUBATED AT 37° C. WITH UREA. ANIMALS FED PREVIOUSLY ON SOYA BEAN FLOUR OR INJECTED WITH 0·3–0·6 ML. ANTUITRIN S. FIGURES IN BRACKETS SHOW NUMBER OF ANIMALS USED

	Upper stomach	Lower stomach	Duodenum plus intestine
Soya bean fed	2·38 (7)	1·10 (6)	0·67 (5)
Control normal fed	1·29 (6)	0·66 (5)	0·71 (5)
Antuitrin S injected	1·85 (5)	1·42 (5)	0·40 (5)

The second finding, in relation to soya bean flour, was tried only on rats; in these animals it is not practicable to divide the mucosa into superficial and deep, while mucosæ had to be analysed in groups of at least three, owing to the very small amounts obtainable (cf. Table 2). Again, there is little change in the intestinal content of the ferment. Soya bean flour was used as, though it is not active itself as a urease enzyme, the enzyme having been destroyed in preparation, it presumably contains a good remnant of the specific protein of urease which normally is present in the soya bean.

Finally, concentrated pregnancy urine was used in the form of Parke Davis Antuitrin S. in amounts varying in different experiments from 0·3–0·6 ml./rat/day from 10–20 days. This extract probably contains a high content of urogastrone. Again, this work has had to be done on rats, and the results are tabulated in Table 2. A definite increase in concentration can be noted.

These three groups of experiments are interesting in so far as they show that the content of a ferment can be varied at the will of the investigator. The presence of urease in such concentrations in the gastric mucosa must have a role in the protection of the mucosa from digestion by acid pepsin. Its involvement in neutralization of hydrochloric acid is being further studied.

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Conditioned Pyridoxine Deficiency in Rats on Diets Containing Flours of Different Extraction-Rates

THE occurrence of what is considered to be a conditioned pyridoxine deficiency in rats receiving a diet of high aneurin content has previously been reported[1]. The deficiency was recognized by the running screaming fits and convulsive seizures observed in the suckling rats, and the absence of fits in the litters of does which were given a supplement of 40 μgm. pyridoxine daily from parturition. In the basal group with a low vitamin B_1 intake, no fits were observed, and the weight graphs of the litters were normal. The basal diet used in the experiments contained about 61 per cent of white flour, and it was observed, although not reported, that in spite of high vitamin B_1 intake, no fits occurred in the litters of a few rats which had received from parturition the same basal diet with National wheatmeal flour (85 per cent extraction) substituted for white flour.

The effect of extraction-rate on the occurrence of this conditioned deficiency has been investigated in a recent series of experiments. The diet used contained the following percentages of constituents: wheat flour, 60·9; commercial casein, 23·9; dried brewers' yeast, 1·9; salt mixture (McCollum 185, with iron citrate), 2·0; calcium carbonate, 0·5; and vitaminized margarine 10·8, with vitamins A, D and E, and small amounts of potassium iodide and manganese sulphate as previously detailed. The flour was of 72, 77, 80 or 85 per cent extraction, all the samples being prepared from the same batch of wheat. We are indebted to Dr. James Sword, Cereal Laboratory, Scottish Co-operative Wholesale Society, for kindly supplying us with these samples. Each group received the high-level addition of aneurin used in the previous experiment, which on the white flour diet gave a vitamin B_1 intake of approximately 11·27 μgm. per Cal.

Growth. Normal rats of comparable initial weights, fed *ad libitum* from weaning on the experimental diets, which differed only in the extraction-rate of the flour used, showed considerable differences in weight after a test period of eight weeks. On the diets containing 72, 77, 80 and 85 per cent extraction flour respectively, the weight increases for the males averaged 191·0, 200·4, 203·7 and 226·8 gm., and for the females 129·8, 152·3, 150·9 and 157·8 gm. In a group which received the 72 per cent flour diet with a pyridoxine supplement of 40 μgm. daily per rat, the males showed an average weight increase of 198·4 gm. and the females 149·1 gm. in the 8 weeks' period.

Breeding Performance. Eight weeks after weaning, the females in each group were mated with males from the same group, and the marked differences found in the breeding performance are summarized in the following table, which indicates the incidence of the characteristic fits due to the conditioned pyridoxine deficiency in the various groups.

Group	Flour (% Extraction)	No. of litters born	Observed fits*: No. of litters showing fits	Observed fits*: Approx. no. of individual fits	Av. weaning wt. of litters (gm.)
A	72%	7	7	110	34·3
C	77%	7	6	43	39·1
D	80%	7	2	13	43·5
E	85%	8	0	0	44·8
B	72% +pyridoxine	6	0	0	42·1

* The rats in all groups were under observation for the same period daily, which was approximately eight hours.

It appears that there is a progressive diminution in the degree of the conditioned pyridoxine deficiency as the extraction-rate of the flour is raised, so that with the 85 per cent flour the imbalance of B factors caused by excessive intake of vitamin B_1 has been corrected sufficiently to prevent the occurrence of the fits typical of this deficiency. It will be noted that there is also a progressive increase in the weaning weights of the young rats with the rising rate of extraction, the difference between the 72 and 85 per cent groups amounting to 10·5 gm. per rat.

Weight of Thymus. The average thymus weights of the rats at weaning in this series of experiments were as follows:

Mean Thymus Weights (gm./100 gm. body weight)

Group	*A*	*B*	*C*	*D*	*E*
Female weanlings	0·254	0·345	0·320	0·328	0·330
Male weanlings	0·205	0·317	0·261	0·280	0·317

For our stock weanlings the values usually found for thymus weight lie between 0·30 and 0·40 gm. per 100 gm. body weight, with an average of about 0·35 gm. The figures illustrate the tendency we generally find in weanling rats for the thymus of the females to be heavier than that of the males. Further, the low values for Group *A* are in accordance with our usual findings in pyridoxine deficiency. When these lower values are considered in conjunction with the lower weaning weight of the group, it will be seen that the absolute reduction in weight of the thymus of these young rats is very considerable. It is known that vitamin B factors other than pyridoxine affect the development of the thymus after weaning, and the higher weights found in Groups *C*, *D* and *E* may doubtless be ascribed in part to the influence of these other factors; but the values found in Group *B* would indicate that pyridoxine alone plays a large part in promoting the development of the thymus before weaning.

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A Rare *Rh* Gene Triad in Mexican Indians

IN a series of ninety-eight Mexican Indians from Tuxpan, Wiener and others[1] tested bloods for the presence of the antigens *A*, *B*, *M*, *N*, *P*, and also four *Rh* antigens. They reported two findings in their first table as follows:

Blood number 9. $OM\ Rh_1Rh_2\ Hr-\ P-$
Blood number 63. $OM\ Rh_1Rh_2\ Hr-\ P-$

The four *Rh* antisera which they used are shown in Table 1, in which the names used by Wiener are compared with those of Fisher, Cappell and myself.

TABLE 1. NOMENCLATURE OF ANTISERA

Wiener	Murray	Fisher	Cappell
Anti-*Rh'*	1	Γ	Anti-*C*
Anti-*Rh''*	2	H	Anti-*E*
Anti-Rh_0	3	Δ	Anti-*D*
Anti-*Hr*	4	γ	Anti-*c*

According to Fisher's conception of the *Rh* antigens[2], it is impossible for bloods of type Rh_1Rh_2 (Murray 153/423 or Fisher *CDe/cDE*) to fail to react with serum 4 (Fisher's γ). If indeed their anti-*Hr* is a potent serum 4 as Wiener and his colleagues claim, and it does not miss occasional single doses of antigen in cells, then the reactions of these two bloods correspond to the phenotype Rh_{123}.

The possible genotypes covered by the phenotype Rh_{123} are shown in Table 2, in which 153/123 (Rh_1Rh_z) is much the least rare. The existence of this rare type has been proved in Britain, and the inheritance of the gene triad 123 (Rh_z) has been traced in a fortuitous family pedigree[3].

TABLE 2

Possible genotypes		Phenotype	Reaction with antisera 1 2 3 4
Rh_1Rh_z	153/123	Rh_{123}	+ + + −
$Rh'Rh_z$	156/123		
Rh_1Rh_y	153/126		
Rh_zRh_z	123/123		
Rh_zRh_y	123/126		

Since both Race[4] and I[5] have found that the frequency of the type Rh_{123} in the British population is only 1 in 1,000, it is remarkable that two such phenotypes should have been found in less than a hundred cases in Mexican Indians. It appears, therefore, that the gene triad 123 (Rh_z) is not so rare in Mexican Indians as it is in the British. It will be interesting to see the relative frequency of this uncommon gene triad in all races, especially in view of the recent suggestion of Fisher and Race[4] that rare types can arise from common ones by cross-over of genes.

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Transfer of Energy Between Centres in Zinc Sulphide Phosphors

IT is well known that the colour of luminescence from zinc sulphide phosphors with at least two types of activator is dependent on the character and intensity of the exciting radiation and also on the temperature. Measurements of the temperature-dependence of the separate emission bands characteristic for each of the activators show that it is very probable that above a certain temperature a transfer of energy takes place from one centre to another. The decrease of the intensity of the blue band above a certain temperature is nearly always accompanied by an increase of the green band. Similar results are obtained for the blue and yellow bands in a phosphor activated with silver and manganese. These and other phenomena can be explained by the following considerations.

Introduction of impurities into a zinc sulphide crystal generally produces new levels between the top of the full S−− band and the bottom of the empty Zn++ band of the pure lattice. These levels, which are normally occupied, can be emptied either by direct ionization through absorption of a light quantum in the impurity centre or by the transfer of an electron to a hole in the full band, the latter arising from the excitation of an electron from the full S−− band to the conduction band. Recombination of free electrons and holes in the impurity levels is responsible for the luminescence. An electron of the full band may also be transferred to an empty impurity-level of an ionized luminescence centre by thermal excitation or by absorption of an infra-red quantum. The hole thus transferred from this level to the S−− band may travel through the lattice until it is recaptured by a similar level or captured by another impurity level.

In this way energy transfer between the centres of different kinds will take place mainly from centres the levels of which are close above the S−− band to a centre in which this distance is larger. Let us assume that in a zinc sulphide phosphor with only blue and green centres the levels belonging to the blue centres are nearer to the full band, and that the transfer of a hole from a green centre back into the full band by thermal excitation is unlikely. We then have during excitation under equilibrium conditions:

$$\frac{dg}{dt} = rq - \alpha_g ng + cb = 0,$$

$$\frac{db}{dt} = (1 - r)q - \alpha_b nb - cb = 0\,;$$

in which q is total number of ionizations of centres per unit time, rq is number of ionizations of green centres per unit time, n is number of free electrons per unit volume, $g(b)$ is number of holes in green (blue) centres per unit volume, $\alpha_g(\alpha_b)$ is recombination coefficient for free electrons and holes in green (blue) centres.

If the cross-section for hole-capture is the same for green and blue centres, then c is given by

$$c = \frac{G}{G + B}\, s \,.\, \exp - E/kT,$$

where $G(B)$ is number of unexcited green (blue) centres per unit volume, s is a constant, and E is distance between 'blue level' and full band.

It can be shown with these equations that the ratio of the intensities of the green and blue emissions during excitation is given by

$$\frac{I_g}{I_b} = \frac{r + c/\sqrt{\alpha q}}{1 - r}, \quad . \quad . \quad . \quad . \quad (1)$$

if $\alpha_g = \alpha_b = \alpha$.

Increasing the temperature increases c, and the colour changes towards green. Increasing the exciting intensity increases q and thus promotes the blue emission. This is in accordance with the observed facts.

While this work was in progress, we received an article of M. Schön[1] published during the War in which in general terms an indication of an explanation along similar lines is given for the colour change of zinc sulphide phosphors with blue and green emission bands.

During phosphorescence the transfer of holes will continue until there is none left in the blue centres. The colour change from blue to green during the afterglow therefore occurs sooner at higher temperatures.

The temperature-dependence curve for the blue band in such a phosphor is given by

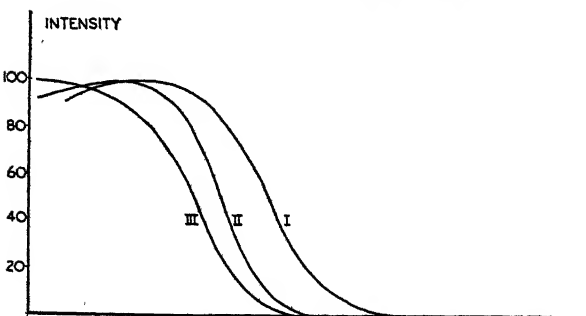
$$\frac{I}{I_0} = \frac{1}{1 + c/\sqrt{\alpha q}}, \quad . \quad . \quad . \quad (2)$$

where I_0 is maximum intensity of the blue band.

$T_{1/2}$, the temperature of 50 per cent quenching ($I/I_0 = \frac{1}{2}$), is thus dependent on the value of q. Increasing the density of excitation by increasing the intensity or by using short-wave ultra-violet or cathode ray excitation shifts the whole temperature-dependence curve towards higher temperatures. This has been confirmed for several zinc sulphide phosphors. $T_{1/2}$ of the blue band is also dependent on the ratio $G/(G + B)$ and is lowered if this ratio is increased. Other centres will have the same effect on the temperature-dependence of the blue band if the distance between the corresponding level and the S^{--} band is larger than that for the blue centres. Such centres are produced, for example, by the introduction of nickel into the lattice, and the accompanying graph shows some temperature-dependence curves of the blue band in zinc sulphide-silver phosphors which contain the same amount of silver but different amounts of nickel.

The nickel centres differ from the green copper centres in that they do not produce any visible radiation. A radiation in the infra-red could not be detected.

Addition of nickel to zinc sulphide-copper phosphors has a similar effect on the green emission of these phosphors. It therefore follows that the levels belonging to the nickel centres are at a still greater distance from the S^{--} band than those belonging to the green centres.



INFLUENCE OF NICKEL ON THE TEMPERATURE-DEPENDENCE CURVE OF THE BLUE EMISSION IN ZINC SULPHIDE PHOSPHORS WITH THE FOLLOWING ADDITIONS.

I. 10^{-2} per cent silver
II. ,, 2×10^{-4} per cent nickel
III. ,, 10^{-3} per cent nickel

During decay the holes will be transferred from the blue and green centres towards the nickel centres. This explains the killing of afterglow by addition of very small amounts of nickel.

Exposure to infra-red light has a similar effect to heating. It was shown experimentally that the decrease in intensity when irradiating with infra-red light during excitation with ultra-violet (*Tilgung*) depends on the number of killing centres (such as nickel-centres). The *Tilgung* also increases when decreasing the intensity of the ultra-violet, keeping the infra-red intensity constant, as is to be expected from the theory.

Fuller accounts of this work, which is being carried out with the collaboration of S. Rothschild and C. G. A. Hill, will be published elsewhere.

I wish to thank Mr. J. A. M. van Moll and the directors of Philips Lamps, Ltd., for permission to publish this work.

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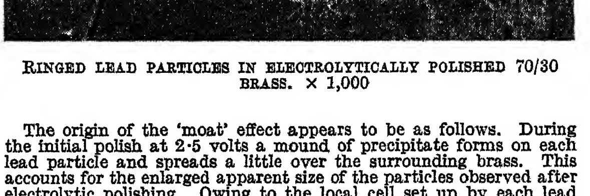
June 19.

[1] Schön, M., *Z. Phys.*, **119**, 470 (1942).

Electrolytic Detection of Small Amounts of Lead in Brass or Zinc

THE electrolytic polishing of multi-phase metals is usually more difficult than that of single-phase metals owing to differing properties, such as electrode potential, of the different phases. This difficulty may be turned into a helpful factor in certain cases. Thus lead may be detected and identified in brass or zinc by making use of the local cell set up between the lead and the ground-mass.

In a 70/30 brass specimen containing 0·1 per cent lead electrolytically polished for 2 min. at 2·5 volts in orthophosphoric acid of specific gravity 1·5, all particles appeared under the microscope as relatively shapeless dark areas. Polishing for 2 min. at 2·5 volts, then for a further 2 min. at 1·8 volts without removing from the solution produced the same result. Reducing the voltage to 1·6, however, produced the structure shown, most particles being now ringed by a 'moat'. Comparison with 70/30 brass specimens free from lead and with others containing 0·005, 0·02 and 0·05 per cent respectively showed the ringed particles to be due to lead; the lead-free specimen showed no ringed particles and the others showed increasing amounts. For all the leaded specimens the transition from unringed to ringed lead particles occurred between 1·8 and 1·6 volts, the voltage being lower the higher the copper content. Some particles were unaffected by voltage changes from 0·5 to 2·5 volts; it was concluded that these were not lead, and this was confirmed by their slight angularity, which was known from observation of hand-polished specimens to be a characteristic of non-lead inclusions.



RINGED LEAD PARTICLES IN ELECTROLYTICALLY POLISHED 70/30 BRASS. × 1,000

The origin of the 'moat' effect appears to be as follows. During the initial polish at 2·5 volts a mound of precipitate forms on each lead particle and spreads a little over the surrounding brass. This accounts for the enlarged apparent size of the particles observed after electrolytic polishing. Owing to the local cell set up by each lead particle, with the lead cathodic to the surrounding brass, the current carried by the lead is reduced to zero at an applied voltage of 1·6, the mound of precipitate dissolves and increased solution of the adjacent brass occurs. According to this explanation, the critical voltage of 1·6–1·8 is equal to the local cell potential in the solution in contact with the specimen, and would therefore be expected to decrease with increase in copper content of the brass.

A similar effect has been found in zinc; for example, 'Tadanac' zinc, which would contain about 0·006 per cent lead, polished for 5 min. at 2·5 volts in orthophosphoric acid of specific gravity 1·375. The particles outline the original as-cast grain boundary. 'Crown Special' zinc polished under the same conditions showed considerably fewer particles corresponding to its lower lead content of 0·002–0·003 per cent. No subsequent polish at a reduced voltage was necessary to obtain ringed particles in zinc specimens, but polishing at a higher voltage tended to eliminate the ring effect. This is in accord with the greater potential to be expected between lead and zinc compared with lead and brass.

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Ministry of Supply,
July 27.

Alpha-Gamma Transformation in Iron-Carbon Alloys

THERE are many indications that the gamma modification of iron-carbon alloys, existing above the temperatures indicated by the lines GS and SE in the iron-carbon diagram[1], should be regarded as heterogeneous and not homogeneous as heretofore.

Experiments based on microscopic and X-ray analysis of quenched hypo- and hyper-eutectoid alloys have provided evidence of the existence of three distinct austenitic pseudo-phases, which may be called γG, γS and γE to correspond to the composition given by points G, S and E, namely, nil, 0 8882 per cent and 1 7764 per cent carbon[2].

In carbon-free iron the austenite is γG only. In hypo-eutectoid steels the austenite grains are of γS composition intersected with plates and needles of γG austenite, the amount of which increases as the composition approaches that of point G. In hyper-eutectoid steels the austenite is γS intersected with plates and needles of γE austenite, the latter increasing in quantity as the composition approaches that of point E.

The composition of all three austenitic pseudo-phases, γG, γS and γE, is stable and corresponds to pure, face-centred cubic iron, one carbon atom associated with six face-centred cubic iron unit cells (24 iron atoms), and one carbon atom associated with three face-centred cubic iron unit cells (12 iron atoms) respectively. When quenched, γG austenite produces ferrite, γS austenite produces martensite, and γE austenite produces retained austenite.

Experiments with various iron-carbon alloys quenched in various ways tend to show that the amounts of ferrite, martensite and retained austenite obtained in the quenched specimen are independent of the quenching-rate so long as a certain critical rate (not determined) is exceeded.

A more detailed discussion of some of the questions which emerge from the above hypothesis will be published in due course.

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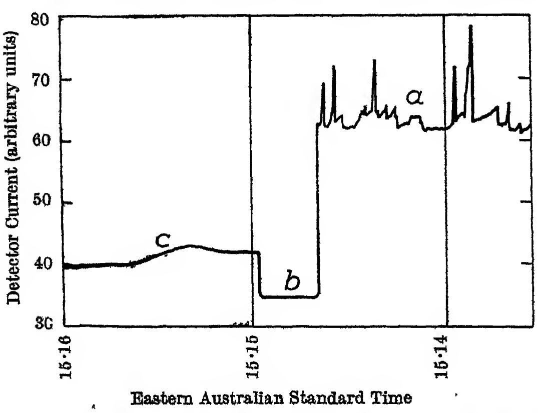
[1] Desch, C. H., "Metallography" (London: Longmans, Green, 1944).
[2] Wrazej, W. J., *J. Iron and Steel Inst.*, No. II, p. 189P (1945).

Polarization of Solar Radio-frequency Emissions

THE recent experimental proof[1] that the sun emits energy on radio frequencies was followed by evidence[2] that the amount of such energy can increase markedly during the passage of important sunspots across the solar disk. Such sunspots are invariably associated with strong magnetic fields, the influence of which almost certainly extends into the upper chromosphere and inner corona. Considerations of optical depth indicate that the observed emissions cannot come from below these levels, so that they must arise in regions where the electron collision frequency is much less than the (radio) wave-frequency, and where the latter is probably of the same order of magnitude as the gyromagnetic frequency He/m. Under these conditions we should expect to find evidence of the magnetic field in the production of gyratory effects at the source of the emissions, and/or in differential absorption of right-handed and left-handed components of polarization during transmission through the corona.

An opportunity occurred of testing this hypothesis during the passage of a large sunspot group across the solar disk in the last week of July 1946. The observations were made on a frequency of 200 Mc./s. with an aerial system which was so disposed as to receive circularly polarized radiation of one sense only (right- or left-handed). This was achieved by the use of four Yagi aerial arrays, of which one set of two was disposed perpendicularly to the other set. In addition, one set was displaced by a quarter of a wave-length from the other, in the line of sight. It is not difficult to show that the output voltage from such a system is zero for circularly polarized radiation of one sense and has the full value appropriate to the field strength for the other sense. It is easy to change the sense of the polarization accepted by changing the sense of the quarter wave displacement.

Observations were made with this system on July 26, when a large northern group of sunspots was approaching the solar meridian. It



SOLAR NOISE RECEIVED AT CANBERRA, JULY 26, 1946
(*a*) Circular right-handed polarization, (*b*) aerials directed away from sun, (*c*) circular left-handed polarization.

was found that the right-handed circularly polarized power received was some seven times greater than that received when the system accepted only left-handed circularly polarized radiation. A portion of the record obtained at this time is shown herewith. It will be noticed also that there is an absence of sudden short bursts on the left-handed system. Three days later, when this spot group had crossed the meridian, these conditions were reversed, five times more power being then received on the left-handed than on the right-handed system.

It would appear, therefore, that the magnetic field of sunspots, and probably the inclination of this field to the line of sight, profoundly affect the radiations observed For this spot group the main field was inclined towards the earth before crossing, and away from the earth after crossing, the solar meridian. Making a solar application of Appleton's magneto-ionic theory of the ionosphere, we may say that our results correspond, in both cases, to the 'extraordinary' ray being stronger than the 'ordinary'.

This work is being carried out on behalf of the Council for Scientific and Industrial Research.

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Canberra.
Aug. 6.

[1] Southworth, *J. Franklin Inst.*, 239, 285 (1945).
[2] Pawsey, Payne, Scott and McReady, *Nature*, 157, 158 (1946).

A Theorem in Statistical Mechanics

STATISTICAL mechanics considers any particular body at given temperature T as a member of a canonical ensemble, that is, the probability of finding it with energy E is given by

$$P \propto \Omega \exp -E/kT,$$

where Ω is the multiplicity of the level E of this body. We can take it that, for the body under test, P is a maximum with regard to any parameter n so that

$$\frac{\partial \log P}{\partial n} = 0 = \frac{\partial \log \Omega}{\partial n} - \frac{1}{kT}\frac{\partial E}{\partial n}.$$

The use of this relation

$$\frac{\partial \log \Omega}{\partial n} = \frac{1}{kT}\frac{\partial E}{\partial n} \quad . \quad . \quad (1)$$

appears to simplify appreciably the treatment of some problems in statistical mechanics. I have not, however, been able to find it mentioned anywhere in the known treatises on the subject.

For example, let a monatomic crystal be given with n holes (Schottky defects). Let each hole contribute an energy ε so that $\partial E/\partial n = \varepsilon$. The multiplicity associated with n holes comes to $(N+n)!/N!\,n!$, where N is the number of atoms in the crystal. The relation (1) yields at once $n = N \exp -\varepsilon/kT$. Expressions for combined Schottky and Frenkel defects are derived in the same way. A second example of the application of (1) is provided by the order-disorder transformation of alloys in the Bragg–Williams approximation. For β brass, for example (following substantially the terminology of Fowler and Guggenheim), an order parameter s is introduced so that for a crystal consisting of $N/2$ each of copper and zinc atoms, the number of zinc atoms occupying zinc sites and also the number of copper atoms occupying copper sites is given by $(1+s)N/4$, and the number of zinc atoms occupying copper sites and also the number of copper atoms occupying zinc sites is given by $(1-s)N/4$. It is readily seen that the number of states for a given s comes to

$$\Omega = \left[\frac{(N/2)\,!}{\{(1+s)N/4\}\,!\,\{(1-s)N/4\}\,!}\right]^2 \quad . \quad (2)$$

Associating an energy $-2\chi_{ZnCu}/z$, $-2\chi_{ZnZn}/z$, $-2\chi_{CuCu}/z$ with each link ZnCu, ZnZn, CuCu, where z is the number of nearest neighbours to each atom, and noting that the probable number of these links is given by $(1+s^2)Nz/4$, $(1-s^2)Nz/8$, $(1-s^2)Nz/8$, we can write down the energy associated with the value s of the order parameter

$$E = -\frac{N}{2}\Big(\{1+s^2\}\chi_{ZnCu} + \tfrac{1}{2}\{1-s^2\}\{\chi_{CuCu}+\chi_{ZnZn}\}\Big). \quad (3)$$

Hence,

$$\frac{\partial \log \Omega}{\partial s} = \frac{N}{2} \log\left(\frac{1-s}{1+s}\right)$$

and

$$\frac{\partial E}{\partial s} = -\frac{sNw}{2}, \text{ with } w = 2\chi_{CuZn} - \chi_{CuCu} - \chi_{ZnZn}$$

The relation (1) then leads at once to the basic equation

$$\log \frac{1+s}{1-s} = \frac{sw}{kT} \quad . \quad . \quad (4)$$

without the use of any more of the apparatus of thermodynamics or statistical mechanics.

It should be mentioned that the relation (1) follows also from the frequently used identification $S = k \log \Omega$ by minimizing the free energy $F = E - TS$, but there the conceptual implications are far less obvious than its connexion with the canonical ensemble.

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Quantization of the Solar System and its Consequences

In an earlier communication[1] I pointed out that our solar system is quantizable according to the equation:

$$n \times 137^k = \frac{\text{orbital impulse}}{2 \times \text{planetary spin}}.$$

Closer scrutiny of the table published there leads to the conclusion that the planets occupy the places of the lowest quantum numbers at their disposal in the order of their sizes. This might be expected: their density and time of revolution can only take values within comparatively narrow limits, and accordingly the quantum number of a planet is approximately inversely proportional to the square of its radius. In the case of each planet the following data can be considered as *a priori* given: its mass, and accordingly, roughly speaking, its extension; its kinetic energy and so its orbital impulse; and lastly the direction of its revolution. While the planets cool down and contract, the proportion between centrifugal force and force of gravitation will undergo a change on their surface. If the maintenance of the kinetic energy of revolution alone were to be considered, the centrifugal force would decrease proportionally with decreasing radius of the planet compared to the force of gravitation. With the decrease of the planetary spin, however, the quantum number would continuously grow. This would be in contradiction to the basic law of quantization. The fact that the places of the lowest quantum numbers are evidently all occupied—and have remained occupied from the beginning—is also against this supposition.

The only remaining solution is that as the planet cools down the quantum number, that is the planetary spin, remains constant, while the kinetic energy of revolution of the planet increases at the expense of its far greater orbital energy. In this case, however (if one neglects the slight changes in orbital impulse), with the decrease of the radius of the planet, the centrifugal force will grow compared to the gravitational force. This leads in time to the loss of the planet's stability. The earth, for example, for reasons of stability could only fill a place in the group $k = 2$ if its density were at least six orders smaller than its present value.

It is interesting, therefore, to examine the stability of a hypothetical planet the mass and speed of which are identical with the total mass and mean speed of the planetoids situated between Jupiter and Mars. The total mass of the planetoids is only 1/800 of the mass of the earth, and so this planet could get—even if its density at its formation was far smaller than the density of Saturn—into the group $k = 3$. As the smallest planet of this group, of the places of low quantum numbers at its disposal, this planet will occupy the highest one, $n = 6$. As in cooling down the density of the planet reached that of Saturn, the centrifugal force at its equator would become equal to the gravitational force, and at the grade of density corresponding to that of Mars it would become double the gravitational force. From its extraordinary smallness it follows that the cooling down of the planet became higher than this, and accordingly it exploded.

Investigations regarding the galactic system render plausible the assumption that our Milky Way is a system in equilibrium in the sense that its stars revolve on Kepplerian orbits around its centre. In the case of our sun, the Planck constant, determining the quantization of its orbit, can be computed from the total impulse of the solar system, $h/2\pi = 3{\cdot}21 \times 10^{50}$. The mass of the solar system is $2{\cdot}00 \times 10^{33}$ gm.; the measurements of its speed give in relation to the globular clusters 275 ± 50 km./sec., to the extragalatic systems 380 ± 110 km./sec. The weighted mean is 304 ± 53 km./sec. The distance of the centre of the galactic system is, from the measurements of Plaskett and Pierls, $10{,}000 \pm 2{,}000$ parsecs; accordingly the orbital impulse of our solar system is $(1{\cdot}88 \pm 0{\cdot}50) \times 10^{83}$ cgs., giving for $k = 6$ the value $n = 0{\cdot}9 \pm 0{\cdot}2 \sim 1$.

The time of revolution of the Milky Way, at the place of the solar system, computed from the shift of the maximum of the Compton-Getting effect of cosmic radiation is 234 ± 10 million years[2]. Using this value, if $n = 1$, the speed of the solar system is 301 ± 13 km./sec., the distance of the centre of the Milky Way $11{,}400 \pm 500$ parsecs and the total mass of our galaxy 4×10^{44} gm. It is remarkable that cosmic radiation measurements seem to furnish more exact data than astronomical measurements alone.

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July 20.

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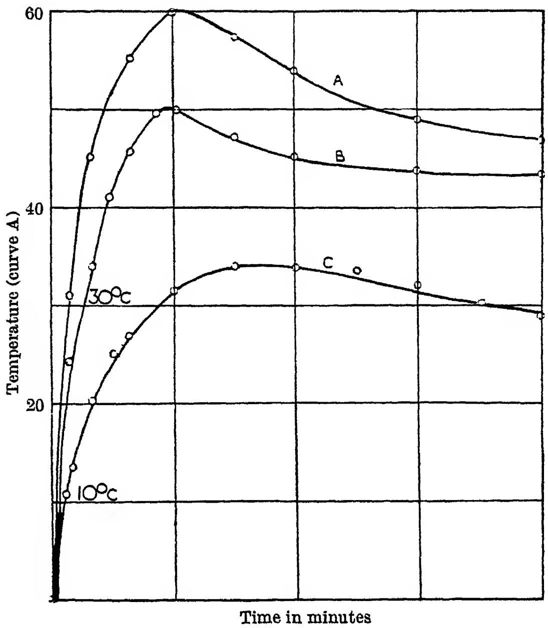
Thermal Inductance

Introduction. The concept of heat flow under a thermal driving force or temperature difference with the applied analogy to the flow of electric charge under an e.m.f. has given rise to the well-known concept of thermal resistance, which has been made the basis of a model method of studying heat-flow problems by the construction of equivalent electrical circuits. Proposed by Langmuir, Adams and Meikle[1] this method has been developed by Beukin[2] and by Paschkis[3], to deal with transients as well as steady-state heat flow. Since, as these authors claim, oscillatory phenomena are not observed in heat-flow problems, the thermal circuits are non-inductive and may be represented by electrical models consisting of resistances and capacities.

The claim that heat flow is non-inductive in nature cannot, however, be upheld in fluid systems. A heated body in a fluid sets up a system of convection currents possessing kinetic energy. In virtue of this kinetic energy, the associated heat flow has the property of inertia; so that if the temperature difference driving the convection current is suddenly changed, we must expect a certain lag before the heat-flow rate settles down to the value appropriate to the new driving force. By analogy with the magnetic field surrounding an electric current, we may take the thermal inductance of the fluid system as proportional to the kinetic energy stored in the 'natural convection field'.



Experimental. Neglecting for the moment the inertia of the convection current, the electric circuit equivalent to the heat flow from a horizontal cylinder immersed in a fluid must consist of a resistance with a distributed capacity representing the thermal capacity of the fluid. The experimental operation consists in suddenly applying heat at a steady and measured rate to the cylinder and measuring the temperature difference between the surface and the bulk of the fluid. In the electrical model the equivalent operation consists in suddenly drawing a steady current and measuring the change in the potential difference. For a network of capacities and resistances, the potential difference will gradually build up to the final steady value. For circuits involving sufficient inductance on the other hand, the initial potential difference may be higher than the final potential difference, which is approached asymptotically from above.

The experimental set-up used to examine the nature of these thermal transients was based on the hot wire device already described[4]. The heated cylinder becomes a short length of resistance wire (26 gauge S.W.G.) to the centre of which was welded a still finer thermocouple of nichrome-constantan. One junction of the couple was attached to the heated wire and the other placed in the liquid about 0·5 cm. horizontally from the hot wire. The heating current was a measure of the rate of heat input, and the thermocouple e.m.f. a measure of the resultant temperature difference.

The hot wire device was immersed in various test fluids and at a stated time a predetermined heating current was suddenly switched on. The e.m.f. of the thermocouple was measured at intervals of ten seconds until final steady values were obtained. Two to ten minutes were required for the temperature difference to settle down to a steady value, the time varying both with the liquid and with the heating current used. In all cases there was an initial rapid rise from zero temperature-difference attributable to the finite thermal capacity of the hot wire itself. The fluids studied included water, various sucrose solutions and hydrocarbon oils covering a wide range of convection moduli. The hot wire was used at various temperatures from about 1° C. above the temperature of the fluid to a few degrees below the boiling point of the liquid concerned. In all examples except those involving very slight temperature differences, the temperature difference – time curve passes through a maximum, and the temperature difference approaches its final value from above.

A few typical temperature difference – time curves for constant heat flow are given in the accompanying graph. Curve A refers to the results obtained with a 70 per cent sucrose solution and wire heated with 1·21 amp. The maximum temperature attained by the wire was 60° C. above the surroundings, the final temperature 47° C. above the surroundings. Curves B and C refer to 40 per cent sucrose solutions; curve B to a heating current of 0·400 amp. (maximum temperature rise 5·0° C., final 4·3° C.) and curve C to 0·305 amp. (maximum temperature rise 3·4° C., final 2·8° C.). Transients of the nature shown by these three curves could not be the product of non-inductive circuits.

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Killara, N.S.W.
Aug. 1.

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OCCURRENCE IN HUMAN SERUM OF YELLOW SUBSTANCES DIFFERENT FROM BILIRUBIN

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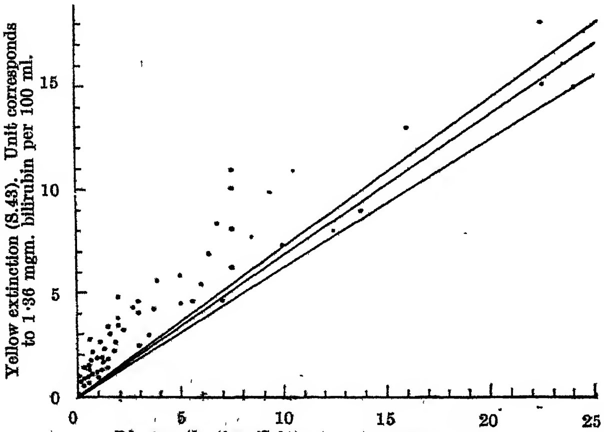
THE yellow colour of human serum is generally assumed to be caused mainly by bilirubin. The bilirubin concentration can be determined by means of the diazo reaction as modified by Jendrassik and Gróf[1,2]. By the addition of pure bilirubin to serum, I was able to demonstrate that the proportion diazo reaction/yellow colour in human serum varied within narrow limits; if both are measured in the Pulfrich photometer, the diazo reaction with the filter *S*.61[1] and the yellow colour with *S*.43[3], the proportion between the extinctions (*E*.61/*E*.43) varies between 1·38 and 1·60 (average 1·455); twenty-five human sera poor in bilirubin to which pure bilirubin was added were investigated[4].

Measurements of *E*.61/*E*.43 in human sera without addition of bilirubin showed great variation, and for most sera values below the lower limit (1·38) for pure bilirubin added to serum. My measurements on twenty-eight normal and thirty-one icteric sera are presented in the accompanying diagram, in which three lines are drawn corresponding to the limits and average (1·38, 1·60 and 1·455) of the proportion *E*.61/*E*.43 for bilirubin added to serum. The diagram shows that most of the sera have considerably more yellow colour than that corresponding to their diazo reaction. This may be due to the presence of yellow substances other than bilirubin, or to partial reaction only of their bilirubin with the diazo reagent; but with the technique used the latter cannot be true[4], and consequently yellow substances different from bilirubin (yellow non-bilirubin) must be present.

A quantitative expression of the yellow non-bilirubin content of a serum may be obtained from the diagram by drawing a vertical line through the point corresponding to the serum in question (defined by its diazo and yellow extinctions). The distance from this point to the point of intersection between the vertical line and the line in the diagram symbolizing the average value of *E*.61/*E*.43 corresponds to the yellow non-bilirubin extinction, and the distance from the point of intersection of the vertical line and the *E*.61/*E*.43 line to the point of intersection of the vertical line and the abscissa corresponds to the yellow extinction of the bilirubin present in the serum. The yellow units of the diagram correspond to 1·36 mgm. bilirubin each. From the diagram it is seen that in most normal sera (diazo extinction less than 2) the yellow non-bilirubin extinction is considerably greater than the yellow bilirubin extinction, and in some icteric sera also this is the case.



Diazo extinction (S.61). 1 unit corresponds to 0·94 mgm. bilirubin per 100 ml.

The chemical nature of the yellow non-bilirubin is not sufficiently known. The carotenoids have to be taken into account, but as the total serum carotenoids —measured as β-carotene—in European populations show concentrations only as low as 10–50γ—and seldom above 100γ—per 100 ml. serum[5,6,7], it can be calculated that their extinction with *S*.43 in most cases is less than 0·1 of our yellow extinction units[3], and as the yellow non-bilirubin concentration most often is greater than 0·5 yellow units (cf. the diagram) the carotenoids can only form a minor part of the yellow non-bilirubin and in most cases an insignificant one.

For biliverdin it is known that its absorption at 660 mμ is three to six times that at 430 mμ, varying with the solvent[8]. The 660-extinction of fifteen normal and ten icteric sera was measured with filter *S*.66 in the Pulfrich photometer and compared with their yellow non-bilirubin extinction, and the fraction *E*.66/*E*.43 varied between 0·07 and 1·10 (average 0·325); as biliverdin shows the value 3–6 for this fraction, only a small part of the yellow non-bilirubin can consist of biliverdin.

Other substances which may form a part of the yellow non-bilirubin are the pyrrol compounds bilifuscin and mesobilifuscin[9,10], which are formed from myoglobin by a process parallel to the formation of bilirubin from hæmoglobin, and according to Engel[11] are also formed during the normal disintegration of hæmoglobin. Further, the so-called xanthorubin, a yellow compound present in the serum of hepatectomized dogs in greater concentration than bilirubin itself[12,13,14], should be considered in this connexion.

As strongly icteric sera generally show yellow non-bilirubin extinctions producing only small fractions of their bilirubin extinctions (cf. diagram), it may be concluded that the elimination of yellow non-bilirubin from the organism must take place chiefly by other means than the liver and bile; further, as the serum in uræmia is not more yellow-coloured than normal serum, the kidneys cannot play any part in its elimination.

The isolation of yellow non-bilirubin for further study will be a difficult task, as its concentration in the serum at the most amounts to *c*.6 extinction units, corresponding to *c*.8 mgm. bilirubin per 100 ml. of serum.

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[2] With, T. K., *Acta med. scandinav.*, **115**, 542 (1943).
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ERADICATION OF TUBERCULOSIS IN CATTLE

IN the course of the last half-century, much has been written on the danger to the human population of the existence of tuberculosis in cattle. There have been strong demands for the elimination of the disease from cattle in Britain, and inevitably opposition to this policy has been roused, on the ground of the magnitude of the task from the economic aspect; the danger of damaging the milk supply of the nation because of the large proportion of milch cows that are tuberculous; the desirability of maintaining infection with tuberculosis in order that the milk of the nation may be infected, so that those consuming it may acquire immunity and withstand the ordinary risks of infection from contact with people suffering from the disease; from a belief that pasteurization destroys a food factor not easily replaceable, and essential for those who depend largely or entirely on a milk diet; and by some because of a mystical belief that animals should be maintained according to what are spoken of vaguely as 'natural' methods.

A great deal of factual information is now available, and experience in other countries strengthens the case of those who favour action to remove a serious source of ill-health in the most important class of livestock in Britain. To-day it can be asserted with confidence that the important agricultural interests are to the fore in the demand for means to get rid of the disease. On many of the questions which were controversial only a few years ago, there is now general agreement.

The history of efforts to control the disease in cattle in all countries is that individual voluntary effort fails to yield results of any considerable value. To attain results which are worth while, operations have to be carried out through the agency of well-organised government departments, supported by certain powers conferred by legislative action, with the co-operation of the industries concerned and under conditions that enable financial aid on a suitable scale to be given to compensate for the special measures required from the owner, until success has been achieved. A primary factor in the organisation for ridding cattle of the disease is the possession of a sufficiently reliable and convenient means of detecting the affected animals. This is provided by the tuberculin test. There are, however, differences of opinion about the most suitable type of tuberculin and the manner in which it should be used.

In the United States of America, an intense nation-wide campaign was carried out by combined Federal and State veterinary departments from 1917, when it was considered that 6–8 per cent of all American cattle were infected, until 1940, when in every county of every State less than one half of one per cent of the cattle were reactors to the tuberculin test and, incidentally, not more than one half of those reactors in 1940 were actually affected with tuberculosis. The tuberculin used in this campaign was prepared from a culture of tubercle bacilli grown on a special nutrient medium consisting entirely of known chemical products and free from proteins. The resultant growth was then concentrated by heating. A more refined type of tuberculin is now available. It is grown similarly on a defined chemical, protein-free culture medium, but it is concentrated chemically, to separate the tuberculin protein, known as 'purified protein derivative' (P.P.D.), from the other constituents of the final growth. The tuberculin prepared officially for use on animals in Great Britain is P.P.D.

There are different ways of using tuberculin. The intradermal test is conceded to be eminently satisfactory in cattle. In the United States, a dose of tuberculin is injected intradermally into a subcaudal fold; there are two natural folds of skin in cattle at the ventral surface of the root of the tail, and the uninjected fold serves as a control. In Great Britain a 'double intradermal' test has been used for the last twenty years or so. A dose of tuberculin is injected intradermally in the skin at one side of the neck, and forty-eight hours later a second dose of tuberculin is injected into the same site.

At the recent congress of the Royal Sanitary Institute at Blackpool, at a meeting of the Section of Veterinary Hygiene, Mr. John Francis, of Imperial Chemical Industries, Ltd. (Biological Laboratories), discussed the tuberculin test in detail and also the control of tuberculosis in cattle, with special reference to conditions in Great Britain.

Prof. T. Dalling, director of the Veterinary Laboratory, Ministry of Agriculture, described work on the disease in progress in Great Britain. He emphasized that, in addition to the great danger to human beings from tuberculosis in cattle, the economic loss sustained by the farming industry and by the State, on account of the extent of the disease in our cattle, is also very important. There is clear evidence that herds free from the disease have a very much higher standard of health than infected herds. When young stock in affected herds are kept apart from the adult cattle, and are not given infected milk, the tuberculosis-rate in them is low. Incidentally, cattle can acquire the disease from contact with infected human beings.

Tests of the usefulness of the vaccination of cattle against the disease have been in progress for some years. Results of some value have been obtained, and it is possible that in certain circumstances vaccination may play a part in control operations. For some years farmers have been encouraged to eliminate the disease through the government Attested Herd and Tuberculin Tested Herd schemes, and a good deal of progress has been made, in that a large number of herds are now so dealt with.

Prof. Dalling explained that investigations of the value of the different types of intradermal tuberculin tests are in progress, and that if a simpler test than the one hitherto used in Great Britain is found to be satisfactory, it will be given consideration by those responsible for policy.

The following resolution was passed at the meeting: "That this section is of the opinion that the Government, in its post-war plans for increasing the efficiency of agriculture and so improving public health, should give high priority to the eradication of bovine tuberculosis".

Closely bound up with the tuberculosis problem, but concerned also with other diseases that affect mankind, is the general question of a safe milk supply. Recent developments are discussed in an article in the *Lancet* of March 2. Among the matters referred to are the pasteurization controversy; the monetary value of the losses due to tuberculosis in cattle (£20–£30 million a year); the marking of cattle that are reactors to the tuberculin test; the

inoculation of calves against bovine brucellosis (contagious abortion); financial assistance required by farmers to help them to free their herds from tuberculosis; the provision of a free State veterinary service; the establishment of a system of eradicating tuberculosis by producing disease-free areas, which would be gradually extended; the provision of a State abattoir service under veterinary supervision, to ensure that the meat supply is sound and, incidentally, to serve as a guide to the incidence of the important diseases of cattle; the need for adequate water supplies on farms and, on a great many farms, for improved buildings.

The article deals with many aspects of the subject and shows in what directions developments are required; and it is to be hoped that, before long, it will be possible to embark on a new stage of the campaign against disease in dairy cattle. What many would like to see would be the first stages of an 'area plan'.

THE SIGNIFICANCE OF SCIENCE FOR INDIA

THE annual address by the president to the Royal Asiatic Society of Bengal is often of much interest to men of science, and that delivered by Prof. M. N. Saha last February is no exception. The earlier part of the address is directed, as is customary, to the affairs of the Society. Prof. Saha mentions the celebrations in January of this year of the bicentenary of the birth of Sir William Jones, the founder of the Asiatick Society in 1784. He records with pleasure the presence at this celebration of delegates from Iran and Afghanistan, and of the writer of this note as the representative of the Royal Society of London. There is no doubt that much good results from such visits and personal contacts, and that scientific workers in their intercourse with those of other countries do much to promote the friendship that is indifferent to, and often cuts across, political trends. When international congresses in science, and other learned activities of man, can be resumed without let and hindrance due to considerations of finance, rationing and politics, the world will be further on the path to peace than appears at present to be the case.

Prof. Saha directs attention, as has often been done before, to the magnificent collection of Sanskrit, Persian and Arabic manuscripts, numbering some fifty thousand, held in trust by the Society for the public. He records the grant by the Government of Bengal of four research fellowships for Sanskrit and Islamic studies and for research in epigraphy and numismatics. A need of the Society that grows more pressing yearly is for new and more commodious premises to replace the beautiful but now structurally unsound building (137 years old) in which the Society is housed at 1 Park Street, Calcutta. Application for financial aid has been made both to the Government of India and to the Government of Bengal. Lord Wavell has himself shown sympathy in this matter.

The main portion of Prof. Saha's address is of unusual interest, because during his period as president he was also a member of the Indian Scientific Mission that visited the United Kingdom and the United States during 1944–45. Later, in 1945, Saha visited the U.S.S.R. as the Indian delegate on the occasion of the 220th anniversary celebrations of the Academy of Sciences of the U.S.S.R. These visits were all made by air. In his address, Prof. Saha is able to discuss in turn scientific activities in Great Britain, the United States and the U.S.S.R., and he speaks with admiration of the work done in each of these three countries during the War. With reference to Great Britain he writes: "Science has saved Britain and led to victory". He summarizes the views of Sir John Anderson and Prof. A. V. Hill that the progress of science and of its application to public welfare depends on the four M's: "Men, money, material, and machinery or organisation", and thinks that Britain will never again allow science to be neglected in her home country. He continues: "Can this be said of India? As far as my knowledge goes, neither Prof. Hill's valuable report, nor the resolution of the National Institute of Sciences that one per cent of the central and provincial budget should be set aside for scientific research, nor the measures of taxation relief in the case of endowments for scientific researches proposed by no less a person than the late Finance Member Sir Jeremy Raisman himself, has yet been considered seriously by the Government of India."

Among many interesting remarks on the development of the United States, Prof. Saha draws a lesson from California: "The people must have the genius to develop the resources with which Nature has bountifully endowed almost every major country. This was nowhere more apparent to us than in the State of California, which, with its green orchards, fertile fields and clear sky reminded us strongly of our own Bengal. We thought that the rainfall must have been as heavy as in Bengal otherwise the country could not be so green and productive. On enquiry we found that the average precipitation was no larger than 16 inches, almost the same as we find in the desert parts of the southern Punjab. Whence comes the life-giving water which nourishes the fields of California?"

The answer is that California is irrigated by water brought some three hundred miles from the Colorado River through an aqueduct. This enterprise and the harnessing of other rivers in America for the development of power leads Prof. Saha to eulogize President Roosevelt for his part in promoting the New Deal in America, and in overcoming the reluctance of the separate States to grant facilities for such projects as the Tennessee Valley Authority.

On his journey to the U.S.S.R., Prof. Saha visited Bahrein and crossed Arabia by air, and this led him to mention the great oil discoveries that have been made in Arabia and the U.S.S.R. as a result of geophysical research, and the necessity of employing such methods in India (the Burmah Oil Co. Ltd. has, of course, been doing this for years). He also records how in the U.S.S.R. the Academy of Sciences has, during the last twenty-five years, been invested with wide administrative powers, with a budget equivalent to nearly 10 crores of rupees (£7,500,000), managing seventy-six research institutions and a number of scientific commissions: in fact, the Academy is the mainspring of scientific life in the U.S.S.R.

Prof. Saha summarizes his conclusions as follows: "Old national boundaries have vanished, and the new age will be one of 'Super States'. Little States cannot survive either politically or economically. The U.S.A. has achieved this position earlier than all other nations because: (a) one hundred and seventy years ago it won the fight to work out its own destiny;

(b) it gave every man the opportunity to develop his own personality, and neither religion nor ethnic origin was any bar [Prof. Saha has overlooked the fact that though this is so constitutionally, yet in practice there is the Negro problem]; (c) the people had the genius to develop the resources of the country, using the latest discoveries in science and technology; (d) there has been a great administrative centre for the whole country, which did not allow any constituent State to secede, or interfere with internal development. Should not we in India remember these great lessons on the eve of our impending political changes?"

L. L. FERMOR

ULTRA-MICRO METHODS IN NUCLEAR CHEMISTRY

G. T. SEABORG has again added to the general knowledge of the trans-uranic elements by his introductory remarks to a meeting of the American Chemical Society and his lecture there on "The Impact of Nuclear Chemistry"[1]. According to the rather tentative definition with which Seaborg prefaces his introductory address, "nuclear chemistry should be defined as embracing the chemical aspects of the study and application of nuclear reactions, the investigation of radio-chemistry, and the application of radio-active isotopes and nuclear methods to the study of chemical problems in general".

The interest of the paper centres in Seaborg's description of the ultra-microchemical methods used in the investigation of the trans-uranic elements. Immediately after the discovery of the first isotopes of neptunium and plutonium, namely, Np 239 (May, 1940), Np 238 and Pu 238 (late in 1940), Pu 239 (spring, 1941) and Np 237 (early in 1942), their chemical properties could be studied only by tracer methods on carriers provided by elements of lower atomic number. However, as it was intended to work out at that early stage the process to be used for the large-scale extraction of plutonium once the piles were working, it was most desirable to test the methods in advance with visible and weighable amounts of material. Therefore, microgram quantities of plutonium and neptunium were produced by prolonged irradiation of uranium with cyclotrons; in order to get concentrations comparable to those in the technical application, the reactions were performed in minute amounts of solution (10^{-1}–10^{-5} c.c.). These are handled with the help of capillary containers, pipettes and burettes. Liquid volumes are measured in calibrated capillary tubing, the movement of the liquid within the capillary being governed by air pressure under sensitive control. The smaller pipettes may be built to fill automatically by capillary attraction. The test-tubes and beakers for this work are made out of capillary tubing with an inside diameter of 0·1–1 mm. The weights of solids handled amount to about 0·1–100 micrograms; a precision of 0·5 per cent is easily reached. Levels are observed under the microscope. Pipettes, etc., are worked with micro-manipulators. Liquids are usually separated from solids by centrifugation rather than filtration.

For weighings, the Salvioni balance is often employed. This has a pan supported by a horizontal quartz fibre, which bends when weights are applied. As an alternative, a balance was developed in the University of California with which 1 μgm. or less, in a container of up to 25 mgm., can be weighed with an accuracy of 2 per cent. In this balance, a beam, to which the two pans are fixed, is supported at right angles to the plane of the beam by a horizontal quartz fibre. When the beam is depressed on one side under a load, it is restored to the initial horizontal position by twisting the supporting quartz fibre. The twist needed is a measure of the load.

Up to 1943, altogether about 1,000 μgm. plutonium (239) were produced in cyclotrons. Not only were reactions in the liquid phase investigated, but also dry reactions, and even the properties of the metal itself. Smaller, but still weighable, quantities of neptunium were also made. In this case, the isotope Np 237 was used, being the only known isotope of neptunium of long half-life ($2\cdot25 \times 10^6$ years). This is the daughter of the β-active U 237 formed by the U 238 (n, $2n$) U 237 reaction. As the latter process is highly endothermic and, therefore, needs fast neutrons, yields are much smaller. Nowadays, of course, Np 237 as well as Pu 239 are made in the piles in quantities sufficient for the application of ordinary chemical methods[2].

Seaborg's researches on elements 95 and 96 have been referred to before[2]. He has now named the two elements 'americium' and 'curium'. The name 'americium', given to the element with six $5f$ electrons, is in analogy to the name 'europium' of the element with six $4f$ electrons. The name 'curium' for the element with seven $5f$ electrons, recalling the pioneers of radioactivity, corresponds to the name 'gadolinium', given to the element with seven $4f$ electrons in honour of the pioneer of the investigation of the rare earths.

It is expected by Seaborg that the starting of the new 184-in. cyclotron in Berkeley will give a new impetus to nuclear chemistry. Employing particles of up to 400 MeV. energy, far-reaching destruction even of lighter nuclei with the emission of showers of protons and neutrons as well as new types of fission are anticipated, leading to new families of radioactive isotopes.

E. BRODA

[1] *Chem. and Eng. News* (May 10, 1946), 1192.
[2] *Nature*, 157, 307 (1946).

IDENTIFICATION OF THE CORONAL LINES

PROF. BENGT EDLÉN delivered the George Darwin Lecture of the Royal Astronomical Society on October 12, 1945, taking as his subject, "The Identification of the Coronal Lines". As a net result of all observations of the coronal line spectrum, the wave-lengths of about twenty coronal emission lines have been established. Six outstanding lines are due to iron, namely, λλ3388, 5303, 6374, 7892, 10747 and 10798. No coronal lines have been observed in a laboratory source of light, and coronal lines were a unique feature of the solar corona until 1932, when a number of them were observed in the spectrum of the recurrent nova *RS* Ophiuchi. Coronal lines reappeared in Nova Ophiuchi at the 1942 outburst and were also observed in 1945 in *T* Pyxidis.

The evidence regarding the nature of 'coronium' is carefully examined, and as a result the conclusion

is reached that the essential part of the coronal lines is due to iron, nickel, calcium and argon atoms deprived of about half their normal electron envelope. Such a high state of ionization raises certain problems in solar phenomena, and various attempts have been made to give a physical explanation to established facts.

The existence of a high temperature in the corona is supported by a number of arguments, among which may be noticed the following, all of which point to a temperature exceeding a quarter of a million degrees: (1) the mean high state of ionization as revealed by the emission lines; (2) the breadth of the emission lines, if this is due to thermal Doppler effect, though macroscopic irregular motions or radial motions of matter might cause the broadening of the lines; (3) the blurring out of the Fraunhofer lines in the continuous spectrum of the inner corona, assumed to be an effect of the velocities of the scattering electrons; (4) the absence of the Balmer lines in the emission line spectrum of the corona, explained by the electrons being too fast to be captured by the protons; (5) dynamical considerations showing that great thermal velocities are necessary to balance the gravitational forces in order to explain the observed density gradient of the corona.

Reference is made to the theory of Alfvén that the corona might consist of particles with very high energy; Alfvén derived from the density function a temperature of about a million degrees. A quotation is given from Alfvén's work which explains the heating mechanism: "Motion of solar matter in magnetic fields on the sun, especially the vortical motion in a sunspot, must bring about a potential difference between different points of the solar surface, and it was shown that under certain conditions this gives rise to discharges above the surface of the sun. Calculations indicate that the electromotive force can be as high as 10^7 volts, so that even if charged particles are usually accelerated only by a small fraction of this potential, they attain rather high energies. The process is most conspicuous in the prominences, where consequently we can expect a very intense production of high energy particles. As the mechanism is of a very general character the same process is likely to take place very frequently on a smaller scale. If—as many authors mean—we can regard the chromosphere as a multitude of small prominences, it is likely that a production of high energy particles takes place almost anywhere on the solar surface or in some layer above it."

Menzel held a different view of the origin of the highly ionized particles in the corona, and suggested that the coronal matter was ejected from the hot interior of the sun through holes and cracks on the surface. More recently, Vegard has expressed a somewhat similar opinion; he thinks that the highly ionized heavy ions in the corona come from the sun's deeper layers, being driven away from the sun at high speeds by means of the electric fields resulting from the photo-electric effect produced by soft X-rays. Saha has suggested that the highly ionized atoms emitting the coronal lines are the fragments of a kind of nuclear fission occurring near the surface of the sun.

At present it would be unwise to pronounce in favour of any one of these views, and the physical explanation of the corona still remains a problem.

BROADCASTING IN GREAT BRITAIN

THE British Broadcasting Corporation is at present operating under the terms of a Royal Charter which came into force on January 1, 1937, for a period of ten years (see *Nature*, 139, 19; 1937). In view of the approaching expiration of this charter, the Government has given careful consideration to the desirability of appointing an independent body to advise on the organisation of British broadcasting in the future. But it has been decided that such an inquiry would not be appropriate at the present time; and that the charter and licence granted to the B.B.C. should be renewed, with certain alterations, for a period of five years from January 1, 1947.

The justification for this action is given in a White Paper* recently published. This paper forms a concise historical review of broadcasting in Great Britain, outlining the policy adopted throughout and the development and activities of the Home and Overseas Services up to and including the war years. On the matter of the appropriateness of an inquiry, it is stated that though the Government is not opposed in principle to the appointment of an independent committee, there are three main reasons for not doing this at the present time or even in one year's time. In the first place, since September 1939, the B.B.C. have been operating under completely abnormal conditions; and the existing charter and licence have therefore run for less than three years under normal conditions; this is an insufficient period to enable a sound judgment to be made of the merits or otherwise of the organisation established in 1937. Secondly, it is too early yet to see with any clarity the effects on peace-time broadcasting of the remarkable developments in the field of electronics and radio-frequency technique which have taken place during the past ten years. Thirdly, the broadcasting service in Britain must operate with due regard to the allocation of wave-lengths for all radio purposes by the International Telecommunications Union; and it will inevitably be some time before the existing agreements can be revised to take account of the geographical and technical changes of the past six years.

In renewing the charter and licence for a period of five years, the Government proposes to consider well in advance of the expiry of this period the desirability of appointing an independent committee to advise on future broadcasting. In the meantime, the B.B.C. will continue to provide its service as a public utility body which is ultimately responsible to Parliament, but which is free so far as possible to carry out its obligations without political interference or control. The Postmaster-General is responsible to Parliament for the broadcasting vote, while the Lord President of the Council now deals with all questions of major broadcasting policy.

The White Paper gives details of the distribution before and during the War of the wave-lengths available to Great Britain, and describes the present arrangement of national and regional stations, and the corresponding programmes. A third programme for Home listeners, intended to be received effectively by about 80 per cent of the population, will be introduced by the B.B.C. in the autumn. An obligation has been laid on the Corporation to broadcast a

* Broadcasting Policy. (Cmd. 6852.) Pp. 28. (London: H.M. Stationery Office, 1946.) 6d. net.

daily account of the proceedings of Parliament by professional reporters, while at the same time an impartial balance must be maintained between parties in all political broadcasting. The present prohibition of commercially sponsored programmes will be maintained, and the Government intends to take all steps within its power to prevent the direction of commercial broadcasts to Britain from abroad. The Empire Services of the B.B.C. are to be maintained and developed, while in addition, many of the foreign language broadcasts must be continued in support of British prestige and influence abroad. These overseas broadcasting services will, however, be financed by an annual grant-in-aid to the Corporation from public funds, so that the whole of the wireless licence net revenue will be available for the Home services.

In order to meet the cost of the post-war development of sound broadcasting programmes, the weekly duration of which is some 50 per cent above the pre-war level, the Government has recently raised the annual charge for a wireless receiving licence, and introduced an additional charge for the domestic reception of television programmes. Apart from the provision of adequate service time, the Paper states that great importance is attached to improving the technical quality of broadcast transmissions to the public. It may confidently be expected, therefore, that for the next five years the broadcasting service in Great Britain will be maintained and improved, so that it will continue, as in the past, to bear favourable comparison with any other service in the world.

THE ACADEMY OF SCIENCES OF THE U.S.S.R.

THE Academy of Sciences of the U.S.S.R. was founded by Peter the Great on January 22, 1724 (Old Style), but began functioning on November 2, 1725 (Old Style) after Peter's death. Its establishment was part of Peter the Great's scheme of widespread cultural and industrial reforms intended to bring Russia into line with the Western European States. In the draft of the structure and functions of the Academy, Peter was guided by the examples of the Royal Society of London and the Paris Academy of Sciences. In commemoration of the 220th anniversary of its existence the Academy has published a substantial, well printed and handsomely illustrated volume entitled: "220 years of the Academy of Sciences of the U.S.S.R., 1945" (Moscow and Leningrad, Acad. of Sci. U.S.S.R., 1945). It is a pity that the book is published only in Russian, with no English or French version, for it provides detailed and easily accessible information concerning the structure of the Academy and its membership.

The introduction is historical. The original idea of Peter the Great was that the Academy should combine research and teaching activities, and this conception lasted until 1803. At first, as was natural, the Academy had few native workers, and the names of eminent foreigners, such as L. Euler and D. Bernoulli, occupy the field. M. V. Lomonosov (1711–65) opened up the road to a succession of brilliant workers in all branches of knowledge. These included M. V. Ostrogradsky (1801–61), P. L. Chebyshev (1801–94), A. M. Boutlerov (1828–86), N. N. Beketov (1827–1911), B. B. Golizyn (1862–1916), S. F. Oldenburg (1863–1934), A. A. Shachmatov (1864–1920), S. M. Soloviev (1820–79) and many others. But many prominent men of science, such as N. I. Lobachevsky and D. I. Mendeleev, were excluded from the Academy through the influence of the Government.

After the Revolution of 1917 the Academy grew rapidly: 1725, 15 academicians; 1925, 48 academicians; 1945, 142 academicians and 208 corresponding members; and of these, 109 academicians and 137 corresponding members, together with some four thousand senior and junior scientific workers, are serving at the various institutions of the Academy. Before 1917, the Academy had five laboratories and five museums, and worked through fifteen committees. In 1945 it embraced fifty-three scientific institutes, possessed sixteen laboratories, thirty-five research stations, fifteen museums and eleven provincial sections and worked through thirty-one committees. All these dependent institutions are now grouped into eight sections: (1) physics and mathematics, (2) chemistry, (3) geology and geography, (4) biology, (5) technology, (6) history and philosophy, (7) economics and law, (8) literature and philology.

In addition to the large number of books published under its auspices, the Academy is responsible for some forty-four periodical, seventy-one non-periodical and nineteen serial publications, all of which are listed in this jubilee volume, as well as books specifically relating to the Academy, biographical, bibliographical and historical. There is also a brief but comprehensive account of every institute, laboratory, research station, museum, library, affiliated society and provincial section, and a short biographical note on each academician and corresponding member—in all, a magnificent work of reference to an ancient but remarkably vigorous and active society.

S. I. TOMKEIEFF

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CHEMISTRY, and a LECTURER IN PHYSICS AND MATHEMATICS—The Clerk, Northern Polytechnic, Holloway, London, N.7 (September 7).

ASSISTANT PHYSICIST—The Superintendent, Christie Hospital and Holt Radium Institute, Withington, Manchester 20 (September 7).

ASSISTANT TO THE CITY ANALYST—The Town Clerk, Civic Hall, Leeds, 1, endorsed 'Asst. to the City Analyst' (September 9).

READER IN CIVIL ENGINEERING (with special interests in Hydraulics and Fluid Mechanics)—The Registrar, The University, Manchester 13 (September 9).

ASSISTANT LECTURER AND DEMONSTRATOR (part-time) IN PHYSICS—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (September 13).

LECTURER IN PUBLIC HEALTH—The Secretary, The University, Aberdeen (September 14).

LECTURER IN ORGANIC CHEMISTRY, a LECTURER OF ASSISTANT LECTURER IN ZOOLOGY, an ASSISTANT LECTURER IN PHYSICS, an ASSISTANT LECTURER (or LECTURER) IN CHEMISTRY, and a TECHNICIAN FOR THE ZOOLOGY LABORATORY—The Registrar, University College, Southampton (September 14).

LECTURER IN APPLIED MATHEMATICS and LECTURERS IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (September 14).

SENIOR PRINCIPAL SCIENTIFIC OFFICER (Senior Mechanical Development and Design Engineer), a SENIOR PRINCIPAL SCIENTIFIC OFFICER or PRINCIPAL SCIENTIFIC OFFICER (Senior Electrical Design Engineer), and PRINCIPAL SCIENTIFIC OFFICERS (Mechanical Design Engineers), at the Atomic Energy Research Establishment, Harwell, Berks—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1613 (September 15).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Reading (September 16).

CHAIR OF THEORETICAL PHYSICS, tenable at King's College, and a READER IN EXPERIMENTAL PHYSICS—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 16).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Reading (September 16).

SENIOR ENGINEER, Power Section, Design and Installation Department of the B.B.C., London—The Engineering Establishment Officer, Broadcasting House, London, W.1 (September 18).

HEAD OF THE ENGINEERING DEPARTMENT of the Paddington Technical Institute—The Education Officer (T.1), County Hall, London, S.E.1 (September 21).

COURTAULD CHAIR OF ANIMAL HUSBANDRY, VETERINARY HYGIENE AND DIETETICS—The Principal, Royal Veterinary College and Hospital, London, N.W.1 (September 23).

SUPERINTENDENT OF THE CHEMISTRY DIVISION, a SUPERINTENDENT OF A DIVISION dealing with FLUTTER, AERO ELASTICITY and GENERAL AIRFRAME VIBRATION, and a SUPERINTENDENT OF THE METALLURGY DIVISION, at the Royal Aircraft Establishment, South Farnborough, under the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1611 (September 30).

BACTERIOLOGIST (which includes the LECTURESHIP IN BACTERIOLOGY at Glasgow University)—The Secretary, Glasgow Royal Infirmary, 135 Buchanan Street, Glasgow, C.1 (September 30).

PROFESSOR OF NATURAL PHILOSOPHY AND DIRECTOR OF THE PHYSICS RESEARCH LABORATORY in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 30).

LECTURER IN ZOOLOGY in the University of Tasmania—The Agent-General for Tasmania, Australia House, Aldwych, London, W.C.2 (September 30).

LECTURER IN CIVIL ENGINEERING—The Secretary, Queen's University, Belfast (October 1).

LECTURER (woman) IN ZOOLOGY—The Registrar, King's College, Durham (October 12).

PHYSICIAN and LECTURER IN PSYCHOLOGICAL MEDICINE—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (October 31).

CONSULTANT by the Government of Iraq for the Irrigation Development Commission to study and advise on problems of reclamation and to undertake soil surveys—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.16738.

SCIENTIFIC ADVISER to the British Council in Paris—The Director, Appointments Department, British Council, 3 Hanover Street, London, W.1, endorsed 'Science, Paris'.

JOINT ASSISTANT DIRECTOR (honours graduate in Physics with advanced research experience in thermodynamics, fluid flow and surface action)—The Secretary, Gas Research Board, 1 Grosvenor Place, London, S.W.1.

RESEARCH BIOCHEMIST—The Secretary, Liverpool Heart Hospital Institute of Research for the Prevention of Disease, 117 Grove Street, Liverpool 7.

AREA SUPERVISOR (to live in the Newport, Shropshire area) for the National Milk Testing and Advisory Scheme—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

LABORATORY STEWARD in the Chemistry Department of the Municipal Technical College—The Chief Education Officer, Nelson Square, Bolton.

LABORATORY STEWARD AND TECHNICIAN to take charge of the Physics Workshop—The Headmaster, Liverpool Institute High School, Mount Street, Liverpool 1.

LABORATORY TECHNICIAN (Grade III)—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff.

CHEMIST to take responsibility for the environmental side of the work of the Department—The Physician in Charge, Department for Research in Industrial Medicine, London Hospital, Whitechapel, London, E.1.

ASSISTANTS (2, male or female) to assist in research work and to look after insect cultures—The Director, Agricultural Research Council, Unit of Insect Physiology, 34a Storey's Way, Cambridge.

RESEARCH CHEMIST—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

SENIOR LABORATORY TECHNICIAN IN THE DEPARTMENT OF BIOCHEMISTRY—The Establishment Officer, University College, Gower Street, London, W.C.1.

LECTURER IN PHYSIOLOGY with ability to teach Anatomy or Chemistry in addition, and a LECTURER IN SOCIAL ADMINISTRATION, in the Department of Hygiene and Public Health, a LECTURER IN PHYSICS, and a LECTURER IN MECHANICAL ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

LECTURER OF BOTANY, to take classes in Botany to B.Sc. (General) standard and Biology to Intermediate Science standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN THE DEPARTMENT OF METALLURGY AND CHEMISTRY, and a LECTURER IN MECHANICAL ENGINEERING, at the Rotherham College of Technology—The Director of Education, Education Offices, Rotherham.

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COLONIAL DEVELOPMENT AND MAN-POWER PROBLEMS

IT has often been remarked that debates on Colonial affairs attract but little attention within or outside Parliament, and the debate in the House of Commons on July 9 was no exception. Following on, however, the issue of two Colonial Office Papers on the Organisation of the Colonial Service and on Post-War Training for the Colonial Service, this debate, in which the Secretary of State for the Colonies made the first peace-time statement of Colonial policy, touches on a number of points of considerable direct and indirect interest to the scientific worker as such. On the broad trend of policy, Mr. George Hall stated that it is the Government's policy to develop the Colonies and their resources so as to enable their peoples speedily and substantially to improve their economic and social conditions, and, as soon as may be practicable, to attain responsible self-government; and he showed that there is no intention of breaking with the policy pursued by the Coalition Government since the Colonial Development and Welfare Act of 1940. Similarly, on matters of detail it appears that more vigorous prosecution of a similar policy under the more favourable conditions of peace-time is contemplated, rather than any radical innovation or reversal of trends.

This is notably true in the field of international co-operation, where, after referring to the agreement of the French and Netherlands Governments to enter the Anglo-Caribbean Commission as full members, Mr. Hall remarked that the Commission has already arranged for co-operation in research and that the Caribbean Research Council had been set up. The last West Indian Conference had already recommended that an international secretariat should be established in the Caribbean area as soon as possible to serve both the Conference and the Commission. Further, it has been decided to call an early conference to set up a regional organisation in the South Pacific for the purpose of exchanging views and information on technical and economic subjects, and a series of conferences have already been held with representatives of the French Ministry of Overseas France and with representatives of the Belgian Colonial Office. Britain has also agreed to share experiences on training for the Colonial Service, and it is hoped to exchange officers in training.

It is proposed, Mr. Hall said, to start in the summer of next year by sending a selected number of officers in training for the British Colonial Administrative Service to Paris for a special course at the National School of France Overseas, while some of the French students in training will come to England to attend part of the course at Oxford for British Colonial administrative trainees. Mr. Hall attaches much importance to this kind of international co-operation, and it should undoubtedly considerably help the development of regional co-operation, in research and in other fields. It is indeed to regional co-operation that we must look for the establishment in overseas

territories of research institutes of sufficient standing and resources to make contributions in most branches of science comparable with those made in the metropolitan country. In certain branches of applied science, the natural location of a research institute may, of course, be in a particular area where a special problem or group of problems is endemic. Ordinarily, however, Colonial territories, even with a regional basis, will rarely possess the resources which can compensate for the drawbacks, such as isolation from the main body of men of science, attendant upon scientific research overseas.

Mr. Hall, in the course of his statement, showed clearly that the Government attaches great importance to research in its policy of encouraging the social and economic progress on which political development depends. Research projects figure prominently among the central schemes for Colonial development, and the past year has seen both the completion of the main structure of the research organisation and a rapid growth in the number of research schemes started. In all, fifty-four new research schemes were approved in the year 1945–46, and the fruit of the years of planning and survey under the wise guidance and leadership of Lord Hailey, as chairman of the Colonial Research Committee, is now beginning to appear as more scientific personnel are released from war work. Mr. Hall said he recognizes the danger that planning of research may get out of touch with the practical problems of the people of the Colonies, and in this connexion visits such as those of the Director of the Colonial Products Research Council to the West Indies, of the Secretary of the Social Science Research Council to West Africa, and of Sir Frank Engledow, Prof. J. W. Munro and the Agricultural Adviser to the Colonial Office to East Africa are important. More attention might well have been given to this question by the Empire Scientific Conference.

There are two aspects of research on Colonial problems which deserve special attention at the present moment: international collaboration and man-power. It is not merely in the training of administrators for the Colonial service that co-operation is important. An article by R. Combes on "Scientific Research in the Colonies" in a recent issue of the *Revue générale des Sciences pures et appliquées* (**53**, 2 (1); 1946) reviews the defects of the present French system of training, and outlines courses intended to improve the quality of recruits for scientific research in the Colonies, the first year of which will be taken in France and the second in the Colony in which the recruit is to work. These courses are intended for the scientific recruit only and are thus more limited in scope than the proposals of the Devonshire Committee and in Sir Ralph Furse's memorandum recently discussed in *Nature* (**158**, 73; 1946). Taken with the creation on the Ivory Coast of an Institute of Intercolonial Teaching and Research, the extension of the French Institute of Africa at Dakar, the formation of an Institute of Central African Studies in equatorial Africa, the re-organisation of scientific work in Madagascar and the creation of a French Institute of Oceania in New Caledonia, they indicate the great importance which France already attaches to scientific research in her Colonial territories.

Moreover, it will be remembered that France has already decided to follow the British example and to transfer her mandated territories in West Africa to trusteeship under the United Nations. It may be taken for granted, therefore, that the further projects for the re-organisation and development of scientific research in the Cameroons and Antilles at least, if not in Indo-China also, which are at present under examination by the French Government, will not be worked out entirely in isolation or without reference to such bodies as the Caribbean Research Council. Regional collaboration, as already indicated, affords the best prospect of establishing research institutes sufficiently equipped and endowed to attract men of the requisite quality in sufficient numbers for really effective work.

It should also be noted that the Royal Society Empire Scientific Conference recorded its view that there is a growing need for the development of long-term fundamental research dealing with African problems on a regional, as distinct from a territorial, basis, and to meet this need it recommended the formation of a Commonwealth African Research Committee. The terms of reference for this Committee include the examination and furthering of proposals for centralizing fundamental research in African problems on a regional basis; the planning ahead of such developments so as to ensure the necessary financial support and the training of the specialist staffs required; and advising the governments concerned through the appropriate authorities on matters of regional development and co-operation in fundamental research. With the reservation that the bulk of fundamental research may for some years continue to be done in Great Britain, there can be little doubt as to the soundness of this proposal. It might, in fact, be suggested that it scarcely goes far enough, and that something on the lines of the Caribbean Research Council or the Middle East Supply Centre is more what is required as regards the extent of co-operation.

Much the same condition applies to university work in the Colonial territories in general, and in the House of Commons debate Mr. Oliver Stanley, like Mr. Hall, indicated his preference for development on the lines recommended in the minority report of the Elliott Commission for precisely such reasons. Mr. Hall said that he has now proposed the establishment of a university college for West Africa in Nigeria, where facilities for students in agriculture, forestry and animal health already exist, which would include a wide range of studies in arts and science, build up research and maintain a suitable standard of admission. While the research school would be established there, each of the three territories should broaden its secondary work so as to increase the number of students who could work to intermediate level and beyond and to further technical education.

Mr. Hall is convinced that West Africa needs a first-class university in fact and not merely in name, and with the shortage of available staff and supplies,

a wide range of arts and science studies in more than one territory is scarcely practicable. This was the main reason why Colonel Stanley regarded with some misgivings the suggestions regarding Fourah Bay College and Achimota College to which Mr. Hall referred. One unitary university is the realistic policy in view of the difficulty of obtaining adequate teaching staff from Great Britain and of obtaining really adequate material. The demand for a second university might well prove fatal to the establishment of the one good university which is possible.

The expansion of research in the Colonial territories and the development of the Colonial universities has to be set against this prime problem of man-power, and the shortage of scientific man-power in particular to which the report of the Barlow Committee directed attention. That expansion and development cannot proceed in the immediate future without regard to the position in Great Britain is clear; for they must for some time to come draw heavily on British man-power resources, however much of the basic research, such as that on which agricultural science depends, is prosecuted in Britain. The discussions at the Royal Society Empire Scientific Conference and the recommendations which were the outcome of that Conference give some indication how serious that demand may well prove, and some of the directions in which a particular shortage of scientific workers may be felt; for example, in such fields as taxonomy, genetics and microbiology. More specifically, in considering post-war needs in fundamental research, the Conference, recognizing the great increase in the number of scientific workers which would be required, considered that it is important that plans for extending fundamental research in any field should be supported by measures designed to increase the number of trained workers able to carry out such plans.

One point which stands out in all the recent papers dealing with aspects of Colonial development, such as training for the Colonial Service, research, or the organisation of the Colonial Service, education and other matters, is this question of man-power. The paper on the Organisation of the Colonial Service*, for example, refers to the need for recruitment of candidates from the United Kingdom and the Dominions on a very considerable scale for a wide variety of posts. The Asquith Commission and the Elliot Commission both recognized that the Colonies will require large numbers of well-trained teachers, medical men, scientific workers, agriculturists, administrators and research workers; and that while these would for the most part have to be trained in Africa or other Colonial territories, the expansion of the Colonial universities to meet that need could only take place with the help of the universities of Great Britain. Reports of the Colonial Research Committee bear similar witness to the dearth of research workers and to the competition with Britain which inevitably arises for the services of such men and women both in the natural and in the social sciences.

* Organisation of the Colonial Service. (Colonial No. 197.) Pp. 12. (London: H.M. Stationery Office, 1946.) 2*d*. net.

Major G. St. J. Orde Browne's report on Labour Conditions in East Africa* similarly points to the need for more trained man-power in the labour departments.

These demands for man-power have, moreover, to be set against the situation in Britain reviewed in the report of the Committee on Scientific Man-power. Since that Committee reported, the findings of the Committee on the Provision for Social and Economic Research have emphasized that the universities of Britain are already under-staffed and under-endowed for that purpose, that provision for research in this field is seriously inadequate and that the supply of qualified staff both for teaching and for the increasing needs of study and research is far short of the level which current conditions and political trends demand. The National Institute of Economic and Social Research, in its last annual report, directed attention to the way in which its research policy is restricted by the severe shortage of trained applied economists, and both the 'working parties' appointed by the President of the Board of Trade which have so far reported have stressed the need for the employment in industry of more scientific workers and trained administrators.

It is already well known that the post-war development plans of a number of industrial firms involve the recruitment of many more trained scientific men than the universities are at present able to supply, and this increased demand competes with the demands for more teachers and for more trained workers for the research associations and for other Government departments. For such reasons it is desirable that the Committee on Scientific Man-power should continue its work and formulate further proposals, as well as a closer analysis of demand, so as to facilitate continual re-assessment of priorities and to increase the efficiency with which the services of trained man-power are utilized. Allocation of man-power may be too complicated to attempt except within the broadest limits, but at least something more could be done to ensure that the best possible use is made of the trained man-power of Great Britain wherever it is employed.

The increasing demand which the programme of nationalization to which the Government is committed may make upon such man-power renders it the more imperative for the Government to set an example in its efficient use. That is one urgent reason for reviewing the whole experience of the research associations, as suggested by the Working Party for the Cotton Industry, and the use of trained man-power in the Colonial Service can be no exception. Furthermore, the recent report from the Select Committee on Estimates regarding the Control Office for Germany and Austria cannot but arouse grave doubts as to whether other departments also are making the most economical use of trained service at their disposal. The causes of superfluity of staff to which this report directs attention are in the main peculiar to the Control Commission, but

* Colonial Office. Labour Conditions in East Africa. Report by Major G. St. J. Orde Browne. (Colonial No. 193.) Pp. ii +94. (London: H.M. Stationery Office, 1946.) 2*s*. net.

the observations of the Committee in regard to quality of staff are not without their bearing on recruitment to the Colonial Service. "The quality of a staff," the Select Committee observes, "ultimately depends, to a very large extent, on their conditions of service. . . . Young, efficient men and women, imbued with proper tradition of service and fired with the moral purpose required, cannot be obtained if their future is to be jeopardised by uncertainty as to their ultimate position." These observations may well apply to the recruitment of staff for scientific research overseas, especially where what is required is research in the field from a Colonial institution for a relatively short term of years. Not merely careful selection of actual staff, but also attention to such matters as superannuation and pension schemes, leave and travel allowances, to which the Empire Scientific Conference also paid marked attention, are important; and a survey of such Colonial Services by the Organisation and Methods Division of the Treasury with the view of closer integration might well be as valuable here as recommended by the Select Committee for the Control Commission.

The most impressive fact which emerges from the Select Committee's review of the Control Commission's staff, however, is that the job the Commission has to do in Germany could be done—and probably done better—by a much smaller staff than the 22,500 people at present employed. Reliable estimates suggest that between 10,000 and 11,000 British men and women of the right type and attracted by terms of service such as the Select Committee suggests would suffice. On that basis we are largely wasting the work of some 11,000 British people, a considerable proportion of whom represent trained man-power. To set that estimate against the figures given in the Barlow Committee's report sufficiently demonstrates the seriousness of this waste, and the importance of taking every possible step to see that, both in Great Britain and in the Colonial Service overseas, the best possible use is made of the limited resources of trained man-power and woman-power.

The Colonial Paper (No. 197) on the Organisation of the Colonial Service gives the clearest picture of what is involved and of the extent to which a Colonial revolution is already in process as Great Britain addresses itself to the tasks to which it is committed by the Colonial Development and Welfare Act no less than by the whole trend of world opinion which has brought the trusteeship system into being. The plan of action set forth in this White Paper is intended to meet three main requirements: the large reinforcements needed by the Colonial Service; the full equipment of such reinforcements for their task; and the adaptation of the structure of the Colonial Service to modern conditions. Such a service must now provide "a framework in which the right man or woman can be put in the right place, irrespective of race or colour; in which there is equality of treatment and opportunity for all on the basis of merit and efficiency; in which the 'passenger' can be disposed of without undue hardship; in which the poorer Colonies stand the best possible chance of getting the staff which they need".

These requirements can be met only by co-operation between the Government of the United Kingdom and the Colonial Governments, legislatures and people. The White Paper indicates that the Government of the United Kingdom will play its full part in the first instance by contributing to the cost and providing opportunities for increasing the supply of qualified Colonial candidates for posts in their own services. A sum of £1,000,000 has already been allocated under the Colonial Development and Welfare Act over the next ten years to enable selected Colonial candidates to receive professional and vocational training which would qualify them for appointment to the higher grades of the Colonial Service. The Government will also assist in the recruitment of qualified staffs as may be necessary in the United Kingdom, and with the co-operation of the university authorities a plan has been worked out by which, as indicated in the Devonshire Report, the main business of post-selection training for the Colonial Service will be carried out for the present in the Universities of Oxford, Cambridge and London, with substantial financial assistance under the Colonial Development and Welfare Act. The idea of setting up a staff college for the Colonial Service has been rejected, after very full consideration, in favour of this plan of using the universities, which will provide opportunities for study before and after a period of Colonial experience; for this post-selection training a further sum of £1,500,000 will be provided under the Act.

To enable the Colonies to secure the services of expert staff which they could not otherwise afford, further *ad hoc* grants may be made, and the White Paper outlines further proposals regarding the structure of the Colonial Service designed to coordinate the distribution of staff so that the available resources are disposed to the best advantages of the Colonies as a whole. To this end a number of principles are set out which should be regarded as objectives for the various Colonial Governments in framing their individual schemes. The salaries of all posts in the public service of a Colony, it is suggested, should be determined according to the nature of the work and the relative responsibilities, irrespective of the race or domicile of the individuals occupying the post; they should be fixed at rates applicable to locally recruited staff, having regard to relevant local circumstances. Expatriation pay should be provided where such basic salaries are insufficient to attract and retain officers from overseas, but the practice of providing free quarters for certain classes of officers should be discontinued. Home-leave at regular intervals and free, or at least assisted, passages for themselves and their families on all necessary travelling occasions should be provided for officers whose homes are not in the Colony in which they serve. Besides recommending a review of serving conditions generally, the White Paper recommends that to ensure that the standard of qualification for the higher posts is maintained, and that the resources of the Service as a whole are utilized to the best advantage in the general interest, the Secretary of State should continue to control appointments to the higher admin-

istrative and professional posts in the Colonial Service, but public service commissions should also be established in the Colonies.

Besides this, it is proposed to provide a central directorate in each group of the biological research services (medical, agricultural, veterinary and fisheries) to advise the Secretary of State as to the programme of research and arrange for its execution in the Colonies and elsewhere. In the non-biological sciences, comprising the survey, geological survey and meteorological branches, which transcend Colonial and even regional boundaries, the central services will be handled as teams of experts directed from the centre according to the needs of the moment, and provision will be made for Colonial Governments to have at their disposal members of the team. Apart from these central services, it is also proposed to develop regional arrangements for the pooling of staff by neighbouring Colonies where suitable conditions for such development exist.

One difficulty in securing the desired flexibility and interchange of staff is the absence of any pension scheme for the Colonial Service as such. The White Paper recognizes the difficulties in the way of a uniform scheme, but emphasizes the desirability of reviewing the main features of the existing Colonial pension laws with the view of securing that the superannuation arrangements are best calculated to contribute to the efficiency of the public service. Several Colonial Governments will be requested to take this action, and admirable principles are laid down for their guidance in the White Paper, which points out that there will still be required a centrally organised scheme to cover expatriate officers serving in Colonies which have no local scheme. Proposals will be submitted to the governments of such Colonies, and in addition a plan is being worked out for establishing a central scheme on the lines of the Federated Superannuation System for Universities to meet the needs of research workers and technical officers in the central services or seconded for limited periods for special work.

It will be clear from this brief summary that these proposals represent a constructive reform long overdue, and fraught with the highest possibilities not merely for Colonial development but also for the more efficient use of trained man-power in that work both in Great Britain and overseas. If, however, the proposals and the schemes which result from them are to have their full effect, scientific workers must make a most important contribution. The weaknesses in the Control Commission of Germany to which the Select Committee directed attention are due largely to the failure to formulate a firm long-term policy either for the whole of Germany or for the British Zone; similarly, no re-organisation of the Colonial Service or development or welfare schemes can be a substitute for clearly defined and firmly pursued policy. Research schemes may prove wasteful and ineffective, for example, unless at the start there are clear conceptions as to the extent to which fundamental research can fruitfully be pursued overseas and the availability of the resources required in such work.

The proposals outlined in these White Papers and by the Secretary of State for the Colonies therefore will require close and continual scrutiny if they are to achieve their purpose. Research programmes must be examined in relation to conditions in Great Britain and overseas to determine where they can be most efficiently pursued; some balance must be maintained between the long-range or fundamental investigations and the short-term objectives. The disposition of staff as between overseas and the United Kingdom and its distribution between research and teaching, between Government service and industry will require constant examination in order to make the best use of our limited resources of man-power. Much of that scrutiny is the affair of scientific workers themselves, and no external administrative reforms or re-organisations can relieve them of that responsibility. In order that the Colonial Development and Welfare Act is to achieve its full purpose and the Colonial revolution it has initiated is to bring its full benefit to the Colonial peoples—and indeed to the people of Great Britain also—scientific workers must realize the greatness of the opportunity that lies before them and respond to the call with all the energy, imagination and vision that they can bring to bear. Continuous informed and constructive criticism as well as moral leadership are the responsibility of the Colonial powers and the condition for realizing the hopes of the new trusteeship system to which in the United Nations Organisation they are already committed.

METHOD IN CHILD PSYCHOLOGY

Psychology of Infancy and Early Childhood
By Prof. Ada Hart Arlitt. (McGraw-Hill Home Economics Series.) Third edition. Pp. xiii + 475. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 19*s*.

DR. ARLITT'S book was first published in 1928. This third edition takes account of many researches since that date. It provides a useful summary and discussion of recent work on such topics as the innate equipment of the infant, reflexes and random activities, habit, perceptual learning and memory. It is, however, a very uneven book and on certain matters, such as emotional and sexual development, it shares the muddled thinking apparent in many American and some English text-books. The general bias is 'behaviouristic' in the narrow Watsonian sense. There is so little understanding of psychical functions as such that it is doubtful whether the book is rightly entitled "Child Psychology".

To me, its main interest lies in its methodology. The author not only tends to think of complex mental processes mainly in 'behaviouristic' terms, but also jumps about from physiological to psychological modes of expression, and back again, without apparently realizing that she is doing so.

If the poet asks:

> "Tell me where is fancy bred
> Or in the heart or in the head?
> How begot, how nourished?
> Reply, reply."

Dr. Arlitt answers: "Love" (as distinct from lust) "is a series of coordinated reflexes controlled largely by the cranial division of the autonomic nervous system plus the perception of these changes together with the ideational content and the stimulus in response to which both appeared". Is anyone really the wiser for this hybrid definition?

Not only are the emotions treated as essentially non-psychical: they are also greatly over-simplified. "When the individual is in love, if it be love and not excitement, he is in an excellent physiological state. Digestion is at its best, the salivary flow is normal, the peristaltic contractions are balanced, neither too rapid nor too slow." This is contrasted with the effects of the "sex drive" (the two being kept quite apart until adolescence). ". . . an individual driven by the appetitive sex drive may find a large number of physiological changes not of a pleasant nature. The general tone may be excited and there may be a rapid shift from the sacral to the central division of the autonomic nervous system, in which case anger, fear and excitement may alternate with the sex drive."

But Freud's work (to which, curiously enough, the author pays a limited tribute in her first chapter and at other places) has shown that 'love' and the 'sex drive' cannot be considered in this sharp separation and contrast. In any event, love is a highly complex state of mind—as the poets have always known. Whether or not it is directed to a consciously sexual object, love commonly carries with it, as well as tenderness, joy and satisfaction, some measure of self-doubt, anxiety, insufficiency, incipient grief and dread of loss: "infinite passion and the pain of finite hearts that yearn".

The inadequacy of the author's account of human emotions is not made up for by the fragmentary 'behaviouristic' physiology in terms of which she attempts to deal with human experience.

Moreover, when questions arise which tend to stir affective responses in all who investigate them, objectivity goes to the winds. Dr. Arlitt swings naively between dogmatic denials of certain facts and practical warnings to parents as to how to *prevent* these denied phenomena. She says, for example, that the period between three and five years of age is "a neutral period in which there appears to be very little interest in sex and in which the side of the sex instinct which is stimulated is largely psychic"—a view which is in flat contradiction to that of most close observers of the behaviour of young children at this age. She holds that questions asked at this period such as, Where do babies come from? "can be interpreted as interest in sex but are probably more truly classified as a phase in the development of language". In the same way she writes: "Body play of a sex type often starts during this period. It should be kept clearly in mind that such activity may, and often does start merely as body play on a level with playing with arms, fingers, toes and the like." (At three to five years, be it noted!) Yet she gives elaborate instructions as to how to avoid the setting up of "bad sex habits". Now if playing with the genital were "on a level" with playing with arms, fingers, toes, etc., why should it be regarded as a "bad sex habit"? And why should such precautions to avoid it as are given on p. 153 be required? The author says: "If masturbation has been developed through carelessness, all the above cautions should be observed, but the child should on no account be made conscious of the fact that the habit is a serious one"!

Evidently one may also read 'the psychologist' for 'the child'. I am reminded of an English educator who said to me, of a mass of evidence showing the frequency of neurotic disturbances in early childhood: "I think your picture is greatly exaggerated. Of course my own children had these troubles, but naturally I took no notice of them."

Experience has long shown how difficult it is to keep the scientific and the didactic points of view apart, and how hardly come by is objectivity, in these fields of inquiry. SUSAN ISAACS

SCIENCE, PHILOSOPHY AND SOCIETY

Problems of Men

By John Dewey. Pp. viii + 424. (New York: Philosophical Library, Inc., 1946.) 5 dollars.

PROF. DEWEY'S new book contains some thirty essays, collected with one exception from periodicals published in the last dozen years. They fall into four sections, entitled "Democracy and Education"; "Human Nature and Scholarship"; "Value and Thought"; and "About Thinkers". Many of the essays in the two earlier sections seem to have been addressed to unprofessional readers; others, in the later sections particularly, contain replies to published criticisms of views which the writer has expounded at length elsewhere. Their collection in a somewhat bulky volume gives a perhaps unavoidable impression of repetition and diffuseness.

To an English reader, Prof. Dewey seems to be at his best in his critical appreciations of the work of other writers. The last section contains essays on James Marsh—a New England scholar who did much to acclimatize Kantian and post-Kantian philosophy in the United States, early in the last century—William James and Whitehead, which are clearly written, sympathetic and illuminating. They are markedly free from a somewhat partisan tone which appears now and then in Prof. Dewey's more popular discussions of current topics. In these passages Prof. Dewey is evidently occupied with contemporary controversies in the United States about the aims of education. His references are often vague; the reader is sometimes left in doubt as to what man, place or century is under review, and just what opponents the writer is combating. (Possibly, of course, an English reader misses allusions which would be obvious on the other side of the Atlantic.) There are evidently schools of thought which hold that higher education in the United States has become too vocational, and is preoccupied with means and techniques at the expense of neglecting ends. Their remedy would be to restore the prestige of strictly non-vocational literary, historical and philosophical studies. Others, again, would reinstate Christian teaching as the foundation of all studies. In opposition to such views as these, Prof. Dewey would insist that scientific methods can be applied to all human affairs; and that such methods do not allow us to assume that there is any repository of wisdom handed down from earlier generations. Prof. Dewey agrees with the traditionalist critics of contemporary education in holding that "the present system . . . is so lacking in unity of aim, material,

and method as to be something of a patchwork", while differing from them radically in his diagnosis and prescriptions. He would ascribe the dispersion of intellectual effort to which he refers, not to preoccupation with the modern technological revolution but to a too timid acceptance of it. Behind those who diagnose neglect of ancient verities he seems to catch a glimpse of the spectres of the inquisitor and the censor.

"Scientific" methods are just as relevant to the traditional problems of philosophy and ethics as they are to practical affairs. In view of Prof. Dewey's stress on this point, it is a little surprising to find that he never refers to the mass of precise and detailed work which has been done in recent years by those who, under the style of "logical positivism" or "logical empiricism", have held out similar hopes of a new scientific method of philosophizing. Prof. Dewey adopts from Lord Russell an important distinction between the "scientific temper" and "scientific techniques". The scientific temper is "cautious, tentative, and piecemeal". But the popular prestige of science is largely due to the spectacular practical effects of scientific techniques; and command of these techniques may produce a sense of "limitless power" and "arrogant certainty" in those whose scientific education has been inadequate. It is the scientific temper, not the popular caricature of it, that Prof. Dewey would have us cultivate.

In the third, the most technical section of his book, Prof. Dewey raises a number of questions on ethics and the theory of knowledge which are of great interest to contemporary philosophers, in a style which unfortunately sometimes becomes impenetrably obscure. Instances may be found in the longest of the essays, on "Logical Conditions of a Scientific Treatment of Morality", apparently written half a century ago. The writer tells us that "by 'scientific' is meant methods of control of formation of judgments", and that "control of moral judgment requires ability to constitute the reciprocal determination of activity and content into an 'object' ". The context does little to lessen the ambiguity of such words as 'control' and 'determine'. "The two marks of scientific procedure", Prof. Dewey writes, "are the determination of *validity* [of a judgment] by reference to possibility of making other judgments upon which the one in question depends, and the determination of *meaning* by reference to the necessity of making other statements to which the one in question entitles us". More simply, we are proceeding scientifically when our judgments, or statements, rest on grounds, and when their meaning can be ascertained by considering what conclusions we can draw from them. This is to use 'science' in a very wide sense. Nevertheless, if ethics is to be scientific in this sense, some possible theories, particularly those commonly called intuitionistic, are excluded.

Prof. Dewey would perhaps go further, and hold that we are not being scientific unless *every* judgment we make rests upon others—or at least is subject to "a critical or inquiring and testing attitude". In that event, the limits he is setting to ethics are still narrower, since he is excluding all theories which allow any self-evident ethical propositions. Thus, in particular, he is excluding not only intuitionistic theories about moral judgments relating to individual situations, but also theories which make those judgments deductions from self-evident general moral principles, in conjunction with the facts of the case.

In a later paper, Prof. Dewey's denial of self-evidence is linked with the claim that "the test and mark of truth" is to be found "in *consequences* of some sort". What appeared as the criterion of meaning in the earlier paper seems now to have become the criterion of truth. The two treatments are reconcilable. But it is difficult to see how Prof. Dewey's 'fallibilism', to use a term he adopts from Peirce, is to escape the well-known objections to the coherence theory. Prof. Dewey claims to hold, in some sense, a 'correspondence', and not a coherence theory of truth; but in just what sense is not very clear. In spite of these difficulties, those who share the writer's empiricist preconceptions will sympathize with his wish to save fallibilism. They will feel in their bones that every empirical judgment must, in some sense or other, be corrigible in the light of further experience, and that in resisting Lord Russell's recent defence of the incorrigible basic proposition Prof. Dewey must be on the right track.

Prof. Dewey's essays contain a number of discernin · *obiter dicta* on the history of philosophy, and are marked throughout by resolution to press principles to their conclusions and to face all difficulties.

The proof reading is not above reproach, and the index might be more comprehensive.

THE TOOLS OF PROTEIN RESEARCH

Advances in Protein Chemistry
Edited by M. L. Anson and John T. Edsall. Vol. 2. Pp. xiii + 443. (New York: Academic Press, Inc., 1945.) 6.50 dollars.

THE structure of proteins is probably the most important and possibly the most difficult of the major unsolved problems of chemistry, at least for the immediate future, and coming at a time when preparations are being made in numerous places to storm this citadel, the present volume is very timely since it gives clear reviews of many of the new methods which will be employed. It reflects the present trend of protein research towards exact analysis and what one might call the 'classical' organic approach to the problem. The X-ray method has clear possibilities, but they are more limited and at the same time involve greater difficulties than was originally expected. In his excellent survey of this field, I. Fankuchen sums up the position with regard to crystalline proteins as follows. "Single protein crystals can be made to yield exceedingly detailed X-ray diagrams and yet one must admit that to date the results of such single crystal studies have been disappointing; disappointing because very beautiful and complete data have so far only yielded comparatively meagre results"—a conclusion which broadly coincides with the views expressed in the discussion at the Roentgen celebration in London. It appears that although we can expect definite information about the number and arrangement of protein molecules in the unit cell, a complete structure analysis lies in the distant future; perhaps not a surprising situation when one contemplates the empirical formula recently given by Brand and his co-workers for lactoglobulin, one of the few cases in which the analyses approach finality, namely, C_{1864} H_{3012} N_{468} S_{21} O_{576}, or particularizing the amino-

acids by easily recognisable abbreviations, as follows: Gly_8 Ala_{29} Val_{21} Leu_{50} $Ileu_{27}$ Pro_{15} Phe_9 $CySH_4$ $(CyS)_8$ Met_9 Try_4 Arg_7 His_4 Lys_{33} Asp_{36} Glu_{24} $(Glu\text{-}NH_2)_{32}$ Ser_{20} Thr_{21} Tyr_9 H_2O_4 ! It might perhaps not unfairly be said that the chief contribution of the X-ray studies has been to demand and stimulate more accurate analyses.

With this vital question of analyses the earlier articles in the present volume are mainly concerned. The international character of the series is worthily maintained by an article on the analytical chemistry of proteins by A. J. P. Martin and R. L. M. Synge, the comprehensiveness of which can be judged from the fact that no less than 771 references to the literature are quoted. An excellent account is given not only of the straightforward chemical methods, but the newer techniques of chromatography as developed by the authors themselves (partition chromatography), by Tiselius (front analysis) and by Wieland, Turba, Block and others.

Complementary to this is an article on the microbiological assay of amino-acids by E. E. Snell. These methods equal the accuracy of the best chemical methods and seem likely to displace them for routine tests now that a considerable variety of suitable organisms is available. This article is appropriately followed by a discussion by R. J. Block of the amino-acid composition of food proteins.

S. W. Fox discusses the identification of the terminal amino-acids of peptides and proteins—perhaps the Achilles' heel of protein research, since if the terminal groups are removed one after another, or if the chain is broken in a suitable number of places and the terminal groups identified, the complete order of the amino-acids can be arrived at in time. It is a little unfortunate that the greatest successes of this method so far, the identification of the terminal groups of insulin by Sanger and the elucidation of the order of the amino-acids in the peptide gramicidin by Synge, should have been published too late to be quoted.

The remainder of the volume is made up of a rather miscellaneous collection of articles on various topics, and the writer cannot do more than indicate their subjects. P. R. Cannon discusses antibody formation from the point of view of the amino-acid requirements involved. C. R. Dawson and M. F. Mallette give a detailed account of the copper proteins, the most interesting examples being the hæmocyanins which function in the blood of invertebrates such as crabs, snails, lobsters, etc., in much the same way as the iron protein, hæmoglobin, in the blood of animals. K. Meyer gives an account of mucoids and glycoproteins, a field which he defines as that of natural substances containing hexosamine. The proteins of this group contain such diverse and interesting substances as the gonadotropic hormones, serum albumen and globulin and egg albumen.

M. J. Blish describes the proteins of wheat gluten, their composition and properties—a matter of profound importance at a time when the most economical utilization of the wheat grain is of urgent interest to a large part of mankind. Within a few days of the start of bread rationing it is strange to read that "until recently wheat was regarded as one of the more serious *surplus commodity* problems", a fact which stimulated inquiry into possible non-food industrial utilizations of the wheat protein!

The remaining articles cover ground, some part of which has been reviewed in other publications not long ago. D. French and J. T. Edsall discuss at considerable length the reactions of formaldehyde with amino-acids and proteins. M. L. Anson gives a clear and detailed picture of the difficult and complicated subject of protein denaturation.

If the editors go on like this, we shall soon have an extensive and up-to-date reference library on proteins. The two volumes which have come out have been in almost continuous use in the writer's laboratory. References to articles which are to be printed in vol. 3 have already been noted and its appearance will be awaited with impatience.

J. A. V. Butler

PROGRESS IN INDUSTRIAL RESEARCH

Industrial Research and Development in the United Kingdom

A Survey. By Sir H. Frank Heath and A. L. Hetherington. Pp. xiii + 375 + 23 plates. (London: Faber and Faber, Ltd., 1946.) 25*s*. net.

THIS comprehensive survey is written for the layman by two authors dubbing themselves as non-experts, but who had in its earlier days much administrative experience in the then newly formed Department of Scientific and Industrial Research. With the aid of numerous experts they trace the growth on the technical side of the major sections of British industry and very briefly describe the efforts made by co-operative research to assist many of them.

The miscalculation on the part of the Department of Scientific and Industrial Research of the time required to establish the research association movement as an essential part of British industry is freely admitted. On the other hand, it does not seem to be realized that during the all-out efforts of war-time, laboratory results may be developed on a large scale with little time-lag, which in peace always tends to be much longer. In a national emergency the cost factor in production is not so much emphasized, with the result that the material benefits arising immediately from research are exaggerated at the end of a great war. This belated discovery on the part of the Department of Scientific and Industrial Research proved to be a greater handicap on those research associations which with slender resources devoted themselves more to solving fundamental problems related to their industry than to obtaining immediate results on a short-term policy. The survey includes the authors' summation of the qualities required for a successful director of a large research organisation.

The often slow and tortuous history of the applications of science in Government Departments and the Services is effectively described.

On the whole, the book may be welcomed as giving an accurate picture of industrial research as it was in the early forties. It does not, however, sufficiently impress the reader with the difficulties of developing laboratory results into large-scale practice. The workers in this immense field will all regret that the authors, with so much experience, have designedly limited themselves to a purely descriptive account of past progress; and have made little attempt to draw general conclusions or to offer advice on future action.

Robert H. Pickard

Papers of the Michigan Academy of Science, Arts and Letters

Vol. 29 (1943). Pp. xiii + 606. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1944.) 5 dollars; 28*s*. net.

THIS volume contains a number of papers in botany, forestry, zoology and other fields.

Two of the botanical papers deal with the marine algæ of Hong Kong and comprise the genera *Herposiphonia* and *Polysiphonia* by C. K. Tseng, University of Michigan. There is also an account of "Some Resupinate Polypores from the Region of the Great Lakes" which is the fifteenth number of a monograph on this subject. The paper contains an extensive key to the principal white resupinate polypores in culture. These fungi are discussed in three groups: (*a*) white, (*b*) brown, (*c*) those other than white and brown. The present paper, in which the first group is treated, is based largely upon studies of the rate of growth in culture and other features. It is intended to serve as a guide to the principal white resupinate polypores in North America.

Under the heading of geography is a paper on "Some Applications of Aerial Photographs to Geographic Inventory" by J. A. Russel, F. W. Foster and K. C. McMurry. It contains an extensive key by which an interpretation from air photographs can be carried out. The key contains features due to topography, drainage, soils, coasts and shores, plant life. Other sections are devoted to the characteristics of occupance such as rural production, transportation and urban forms. The section on plant life is detailed and should be of considerable value in the interpretation from aerial photographs of the distribution of different types of vegetation.

Den Danske Dyreverden

Dyregeografisk og indvandringshistorisk belyst. Af Ragnar Spärck. Pp. 116. (København: Ejnar Munksgaard, 1942.) 7.50 kr.

IN this book Ragnar Spärck has written an excellent summary of the general problems connected with the present distribution of the Danish fauna. At the present day, Denmark possesses a very uniform climate and a topography without extremes, and as would be expected under such conditions the majority of the species comprising the fauna are distributed over the whole area wherever they may find suitable habitats. A number of species are, however, confined to the southern districts and islands, some with a westerly and some with an easterly distribution. Rägnar Sparck has studied the distribution of these species in order to determine whether such distribution is due to human interference, climatic or ecological factors, or whether it has some reference to the period at which the species entered the country. The species considered are mostly vertebrates, but consideration is given to the distribution of a number of invertebrates, and there is a chapter on the fauna of the surrounding sea.

There is an excellent series of maps showing the distribution of certain species in Denmark, but it is a pity that these are confined to Denmark alone and that the distribution of the species in the Scandinavian Peninsula or elsewhere in Europe is not shown.

This book will be of great interest to all who are concerned in problems connected with the zoogeography of Northern Europe and post-glacial migration of the European fauna.

Language as a Social and Political Factor in Europe

By Stanley Rundle. Pp. 207. (London: Faber and Faber, Ltd., 1946.) 12*s*. 6*d*. net.

AS an example of the serious misunderstandings that can arise from lack of a common tongue Mr. Rundle quotes, among a number of instances, the English padre in the First World War who offered a benediction to some French troops in the words "Que Dieu vous blesse", and the story is characteristic of a book that treats a technical subject in a way that cannot fail to appeal to the non-specialist reader while conveying to him much sound and thoughtful information. The first part of the book sets out the difficulties caused by language differences, which Mr. Rundle summarizes in eight points. In the second part he gives a quantity of statistical and other material on the languages of Europe, and in the third he deals with the various projects for overcoming the difficulties, whether by learning a variety of languages, or agreeing to adopt one existing language, or forming a new, "artificial" language. To each of these suggestions he applies the test of his eight points, and though he offers no final conclusion the ideas he throws out are stimulating and provocative. His suggestion of three simple international languages, based on the division of Europe into three main language groups, Romance, Teutonic and Slav, though put forward almost as an afterthought, is at least as worthy of consideration as some of the other projects which he summarizes, and in passing he has some interesting suggestions to make about the teaching and learning of languages.

MAURICE BRUCE

The Chemical Composition of Foods

By Dr. R. A. McCance and Dr. E. M. Widdowson. (Medical Research Council, Special Report Series No. 235.) Second edition. Pp. 156. (London: H.M. Stationery Office, 1946.) 6*s*. net.

DURING the six years of its existence McCance and Widdowson's "The Chemical Composition of Foods" has come to be justly valued as the most comprehensive and authoritative compilation of its kind in Britain (and, indeed, in some respects, such as the mineral contents, in the world). The call for a second edition has prompted the authors to expand, and occasionally to modify, their initial findings. The expansion has swelled the number of entries from 541 to 609, the additions mainly stemming from war-conditioned alterations in the British dietary. Thus where two flours (white and wholemeal) were sufficient in 1940, no less than sixteen varieties have been entered in the 1946 edition. Among other newcomers are dried egg, household dried milk, chopped ham, and "sausage (1943)"—an ominous description that is belied, at least nutritionally, by the analytical data given. Several "economical" variants have been added to the long and useful list of cooked dishes, while the number of recipes has been correspondingly enlarged. This section of the Report, which takes into consideration such significant details as mechanical losses of raw materials during mixing, will be invaluable to dietitians. Catering, as they do, for a wide range of users, the authors continue to express compositions per ounce as well as per 100 "grammes" (but why this archaism ?).

One notable change in this edition is that the 1940 table of "available" (ionizable) iron contents has been dropped—a step reflecting recent changes in our ideas about iron availability.

N. T. GRIDGEMAN

THE AUSTIN WING OF THE CAVENDISH LABORATORY

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

IN May 1936 the late Lord Austin sent the following letter to the Chancellor of the University of Cambridge :

"DEAR MR. BALDWIN,

"I have for several years been watching the very valuable work done by Lord Rutherford and his colleagues at Cambridge in the realm of scientific research, and knowing that as Chancellor you are keenly interested in obtaining sufficient funds to build, equip, and endow a very much-needed addition to the present resources, I shall be very pleased indeed to present securities to the value of approximately £250,000 for this purpose.

Yours sincerely,
H. AUSTIN."

Of this munificent gift, a sum of £37,000 was at once applied to building and equipping a high-tension laboratory and installing a cyclotron. A further sum of £100,000 was set apart as a building fund ; £80,000 for a new wing of the Laboratory and £20,000 for alterations to the existing Cavendish block. The residue provides an annual income for the general research of the Laboratory.

The plans for the new wing were completed before Lord Rutherford's death; but the actual building was not started until May 1938. Though many in the Laboratory had a part in the designs, the main responsibility for the plans rested upon Prof. J. D. Cockcroft. Building had not progressed very far at the outbreak of war, and at one time it appeared that work on it might have to stop. We were able to proceed, however, by giving an undertaking that accommodation would be found in the Laboratory for Service research departments if need should arise. Lord Austin laid the foundation stone in May 1939, and the building was completed by June 1940. It was at once occupied by the Admiralty Signal School and the Ballistics Directorate, Research Department, Woolwich, both of which had been driven from their homes by air attacks. Towards the end of the War, some sections of the building were handed back to the Laboratory, but we were not able to occupy the whole until January 1945. It had then to be decorated, furnished and provided with apparatus and machine tools ; it is now in full running order. The new wing was formally opened by Sir John Anderson on July 24 of this year, during the international physics conference arranged jointly by the Physical Society and the Cavendish Laboratory.

The architect, Mr. C. Holden, assisted by Mr. H. G. Cherry, designed for us a building which is very simple in plan, and at the same time is attractive and very convenient. It is 115 ft. in length by 45 ft. in width, and 55 ft. in height. Each of the four floors and the basement are of similar design, with rooms of standard size or multiples of this size on either side of a central corridor 8 ft. wide and 13 ft. high running the whole length of the building. The standard research room is 15 ft. by 17 ft., with two windows. The outer walls and walls of the corridor carry the strong concrete floors, on which rest light walls separating the research rooms, so that it is a simple matter to subdivide a room or to remove a dividing wall. There are also removable panels above the doors, and with so high and wide a corridor it is possible to move quite large units of apparatus into any room. The area occupied by the building is 9,000 sq. ft., and the total floor-space 34,000 sq. ft.

In planning the services to the rooms, flexibility was aimed at rather than a complete provision for all possible needs. The services come up a shaft next the lift-shaft, run along the sides of the corridors above the doors on open battens, and then enter the research rooms, so that it is easy to alter or add to them. The standard supplies of gas, water, electricity and compressed air are distributed around the walls of the rooms above a narrow shelf which corresponds in height to the tables used for research, leaving the centre of each room quite free. The electrical supplies from the D.C. generators are available in any room, and can be controlled from it.

The second floor houses the administrative centre of the whole Laboratory. It has rooms for the senior teaching staff and the clerical staff. A large bay is used for the museum of historic apparatus, and on its walls are displayed the annual

FIG. 1. EXTERIOR OF AUSTIN WING

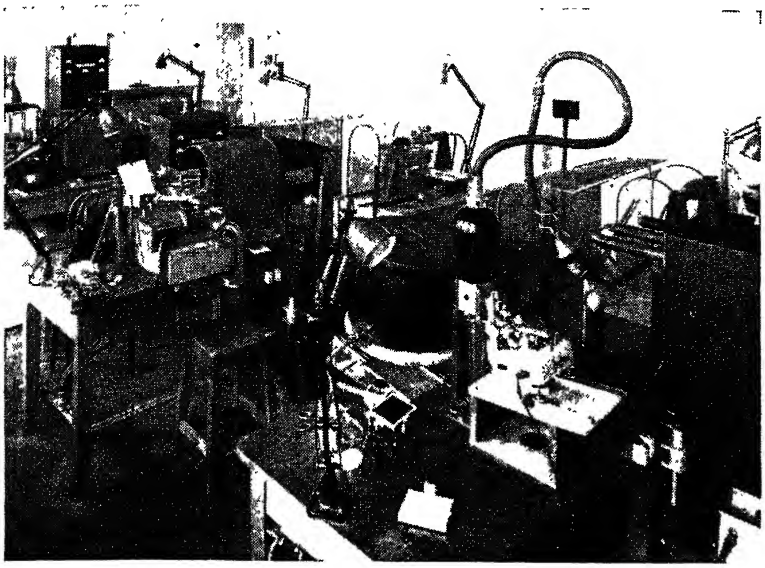

FIG. 2. A TYPICAL RESEARCH ROOM

photographs of staff and research students, a remarkable series running from 1897 which has only been broken during the two World Wars. A large room on this floor with an attached pantry is used for the Cavendish 'teas' and other social gatherings, and for conferences and committee meetings. The library is also on the second floor. The style of the rest of the Laboratory is purely functional, but on this floor we have aimed at providing a fitting Laboratory centre. In designing the furniture and decorations we had the help of Mrs. Hubert Worthington. A colloquium room seating about seventy is on the first floor beneath the library.

Another group of rooms provides for the main workshop, steward's office, students' workshop, glassblower's rooms, general storeroom, and standards room. There is also a 'special techniques' workshop where delicate operations requiring the highest technical skill are carried out.

Of the ninety rooms in the building, thirty-one are research rooms of unit or multiple unit size, and thirteen are offices. Store-rooms, dark rooms, generator room, heating and other services, together with the special rooms mentioned above, account for the remainder. No part of the building is used for undergraduate teaching, though all students use the library.

Even with the most careful planning and foresight, certain needs only become apparent when a building comes into service. Much apparatus for physical research is now on an engineering scale. A large covered space near the workshop, for packing and unpacking and for storing gear before it is assembled, would be a great boon, and it is not provided for in the present wing, which had to be planned on a restricted site. The amount of 'junk' carried by the Laboratory is also on a correspondingly large scale. It is a most important liquid asset, exceedingly useful for research purposes of all kinds. A large space should be set aside for it where it is easily accessible and can be classified, otherwise it clutters up valuable research rooms or the corridors. Another need is for many more small 'offices'. In former days a researcher, working with small-scale apparatus, could have a desk in the corner of his laboratory, where he kept his papers and did his calculations. Now that many research rooms resemble the interior of a power-station, this is no longer convenient. Researchers greatly value private cubicles, however small, where they can work or talk with their colleagues in quiet surroundings. I mention these needs because our experience may be of interest to others who are planning laboratory extensions. On the whole, the planning of the new wing has been highly successful, and the competition to work in its convenient and attractive research rooms is very keen.

The building cost £77,000, apparatus and equipment £10,000, furniture and fittings £4,500. We were indeed fortunate that it was built at the beginning of the War; quite apart from the cost, the same high standards will be impossible to attain for many years to come.

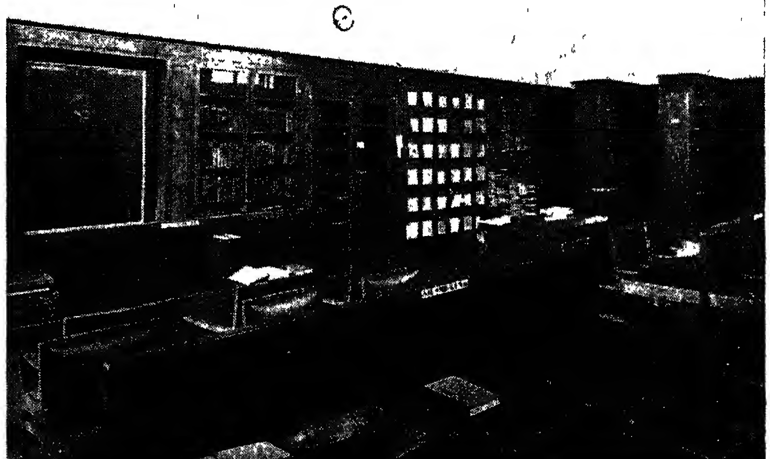

FIG. 3. LIBRARY

CENTENARY OF THE SMITHSONIAN INSTITUTION

THE Smithsonian Institution was established on August 10, 1846, in accordance with the terms of the will of James Smithson, a wealthy Englishman interested in science. At his death, seventeen years before, he had left his fortune of approximately 550,000 dollars to the United States to set up in Washington an institution "for the increase and diffusion of knowledge among men".

The establishment thus became the first of the great endowed scientific organisations which have been in a major degree responsible for the great cultural and material progress of the last century. federal appropriations—notably the National Museum, the Bureau of American Ethnology, the Astrophysical Observatory, the International Exchange Service, the National Zoological Park, the National Collection of Fine Arts, and the Freer Gallery of Art. The National Gallery of Art also is a bureau of the Institution, but is administered by a separate Board of Trustees. In addition, the Institution carries out independent pioneer work with its own funds.

The Smithsonian Institution has become known to the general public for its enormous collections, many of which are on continuous exhibition, ranging from dinosaurs to aeroplanes and from famous paintings to the dresses of Presidents' wives. The great value of the collections, however, is in their service to science. Here it is possible for experts to check the identity of

THE SMITHSONIAN INSTITUTION

Among all such institutions everywhere the Smithsonian has had a unique position. It has been intimately associated with the National Government, yet at the same time it has had the freedom of action associated with private foundations. It has been from the beginning a torch-bearer of scientific research in the United States. At the time of its establishment the pursuit of science was largely that of interested individuals, dependent on their own resources, which never were adequate for the long-term, basic, laborious researches essential for a true understanding of Nature.

Owing to its close association with the Government, the Smithsonian has enjoyed exceptional facilities from the beginning. To-day it administers and directs the research activities of several scientific and cultural bureaux, most of which are supported by direct

nearly any animal, plant, or mineral found in the world, either extinct or extant. These collections now include nearly twenty million items—a number that increases constantly at a rate of more than a quarter of a million a year. The greatest number of items is in the field of natural history. In the beginning the Smithsonian had essentially a scientifically unexplored continent as a field for its collectors and explorers. Year after year it has sent out collecting expeditions to all parts of the world, including, of course, all sections of the United States.

The interest of Smithsonian explorers has been to obtain and preserve as complete as possible a picture of all Nature in its infinite manifestations. The Institution maintains departments in all the major branches of natural history, from entomology to physical anthropology.

The Smithsonian was the pioneer, and ever since has been among the leaders, in all scientific research dealing with the aboriginal peoples of the Americas. These now are conducted largely by a Government-supported division—the Bureau of American Ethnology. At the time this work started just after the American Civil War, scientific interest in the remains, languages, and ways of primitive peoples was in its infancy. Thus the work of the Bureau, with the exceptional facilities at its disposal, has been fundamental in the development of the entire science of ethnology, and its publications are considered basic documents of this science all over the world.

Samuel P. Langley was a pioneer in the development of aviation. His steam-driven model "aerodromes" flew without a pilot repeatedly for distances of more than half a mile as early as 1896. The Smithsonian collection of aeroplanes which have played notable parts in aviation history is probably the largest in the world.

Study of precise solar-terrestrial relationships has been a major Smithsonian activity for many years. This has involved especially very exact measurements of periodic variations in the sun's radiation and the mechanism of photosynthesis in green plants. Observations now are carried out daily at three observatories on high mountain-tops in California, New Mexico, and Chile. This work has required development of measuring instruments of almost incredible delicacy—one of them capable of measuring a change of heat as small as one-millionth of a degree.

In the United States originated such devices as the telegraph and telephone, the cotton gin, the sewing machine, the harvester, and scores of others. The original machines are objects of historic interest to the American people. The Smithsonian has the responsibility for collecting and preserving these historic prototypes. The Museum collections of the Smithsonian are visited by more than two million persons each year.

The American history collections are especially rich. Perhaps the best-known items are dresses of ladies of the White House from Martha Washington to Mrs. Franklin D. Roosevelt.

In carrying on "the diffusion of knowledge", the Institution has published more than 7,500 individual books and pamphlets in nearly every field of science, most of them based on original research. It also maintains a large library of scientific books and pamphlets, covering all the fields in which it is chiefly engaged.

In the field of art the Smithsonian has three bureaux, as follows:

The National Gallery of Art, given to the nation by the late Andrew W. Mellon and containing his own collections, as well as other famous collections. The National Gallery is administered by a separate Board of Trustees.

The Freer Gallery of Art, one of the most important collections of Oriental art in America, a gift to the people of the United States from the late Charles L. Freer of Detroit.

The National Collection of Fine Arts, a generalized collection which is temporarily housed in the U.S. National Museum, pending authorization of a new building.

A FREQUENCY ANALYSER USED IN THE STUDY OF OCEAN WAVES

By N. F. BARBER, F. URSELL, J. DARBYSHIRE
AND
M. J. TUCKER
Admiralty Research Laboratory, Teddington

A WAVE-ANALYSER was developed at the Admiralty Research Laboratory, Teddington, in 1944 in order to analyse ocean waves and swell and ship movement. The apparatus has been in regular use since February 1945 drawing the frequency spectra of records of wave motion taken near Lands End.

These records of water pressure or depth are taken continuously for 20 minutes, and appear in the form of a black trace of variable width on white photographic paper. Fig. 1 shows a short length of record. On one side of the record is a time trace

Fig. 1. A WAVE-PRESSURE RECORD

consisting of a black strip interrupted every 20 sec. By attaching the paper record to the outside of the rotating wheel in Fig. 2, photocells, illuminated by the reflected light from a narrow light beam falling on the record, give a fluctuating electrical output which is a repetition at high speed of the fluctuating trace on the record.

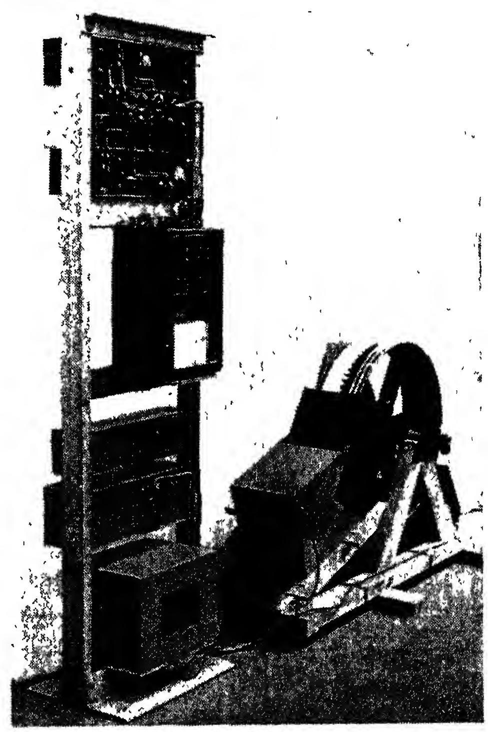

Fig. 2. THE FREQUENCY ANALYSER

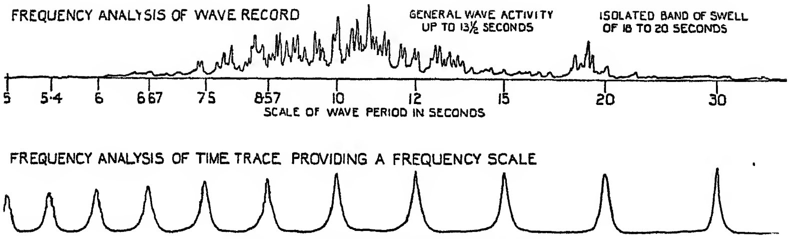

Fig. 3. TYPICAL FREQUENCY ANALYSIS

This electrical output is amplified and made to drive a vibration galvanometer. By allowing the speed of the rotating wheel to decrease slowly, the vibration galvanometer is caused to resonate in turn with the various component wave-lengths on the original record. Thus the vibration galvanometer of natural frequency 120 c. per sec. resonates with the output of a wave-length 1/30 of the periphery of the wheel when the wheel is turning at 4 rev. per sec., but resonates with the output from a wave-length 1/40 of the periphery of the wheel when the speed of the wheel has fallen to 3 rev. per sec. Regarding the record as being compounded of its Fourier harmonics, each having a whole number of wave-lengths on the periphery of the wheel, one can see that provided the vibration galvanometer is sharply tuned and that the speed of the wheel decreases very slowly, the vibration galvanometer will show individual resonances to each Fourier component.

The motion of the galvanometer is detected photo-electrically and the output is amplified, rectified and made to drive a pen recorder the deflexion of which at any instant is, therefore, a measure of the amplitude of vibration of the galvanometer. The most recent model uses a vibration galvanometer with an electrical output, developed by G. Collins. The sample pen record shown in Fig. 3 is the analysis of the record of which Fig. 1 is a portion.

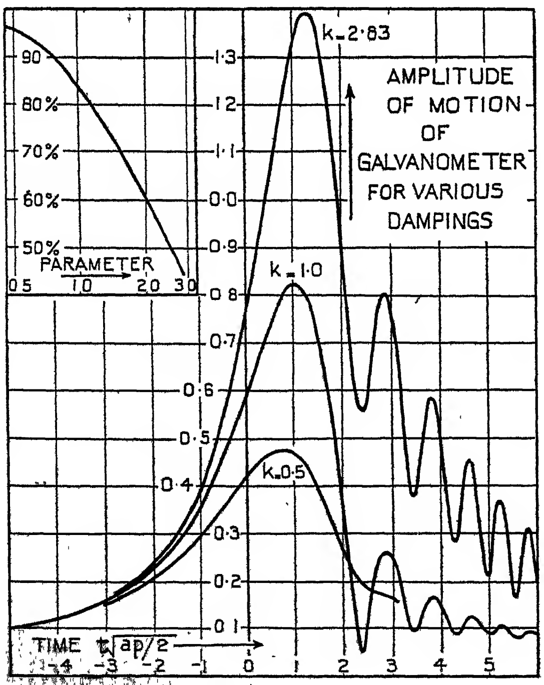

Fig. 4. AMPLITUDE OF OSCILLATION OF GALVANOMETER FOR VARIOUS DAMPINGS

A frequency scale is drawn automatically by a second pen giving the lower trace in Fig 3. This pen is actuated by a second channel working photo-electrically from the time trace and using a resonant filter tuned to 360 cycles. The second pen, therefore, draws a frequency analysis of the time trace, and this consists of a series of isolated peaks which can be used to interpolate a scale of frequency for the trace of the first pen. Because of the 3 : 1 ratio in the resonant frequencies of the two channels, these peaks are equivalent to wave-periods of submultiples of 3 × 20 or 60 sec., that is, 60, 30, 20, 15, 12, 10 sec., and so on.

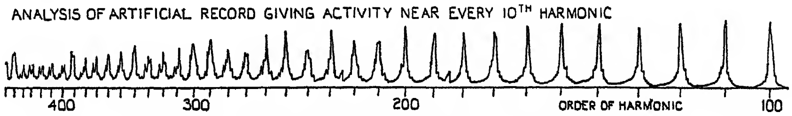

Fig. 5. ANALYSIS OF ARTIFICIAL RECORD SHOWING RESOLUTION OF FREQUENCY BANDS

It will be appreciated that the mechanical parts of the apparatus are simple and that the process of analysis is automatic. There is no mechanical drive to the wheel, which, having been turned by hand to its top speed, continues to revolve under its own inertia at a slowly decreasing speed, the analysis proceeding automatically. In the apparatus already built, the wheel is 30 in. in diameter and weighs 70 lb.; it is carried in ball bearings, and takes about 4 minutes to decrease to half speed. As for the electronic amplifiers, it is not necessary for them to have an amplification which is the same over a wide range of frequency, since the only electrical frequencies that are important are in a narrow belt near 120 c. per sec. It is important, however, that the amplifiers should be linear in the sense that they produce no spurious 120 cycles coming from sum or difference of the various frequencies in the input. Linearity is also important in the optical pick-up from the record, in the sense that the illumination of the photo-electric cell must be strictly proportional to the width of the white part of the illuminated area of the record.

In practice, it is found that an analysis covering four octaves takes place in about 16 minutes, and that an operator can deal conveniently with about fifteen analyses each day.

The analysis approximates to a Fourier amplitude analysis, and it has been found possible to determine theoretically the optimum characteristics of the apparatus. Each of the Fourier components of the record produces an electrical component the frequency of which is slowly gliding as the wheel decreases in speed. If the speed of the wheel decreases at a rate exp $-at$ and the vibration galvanometer has a natural frequency $p/2\pi$ and a natural rate of decay of free oscillations of exp $-bt$, then it can be shown that the manner in which the oscillations of the

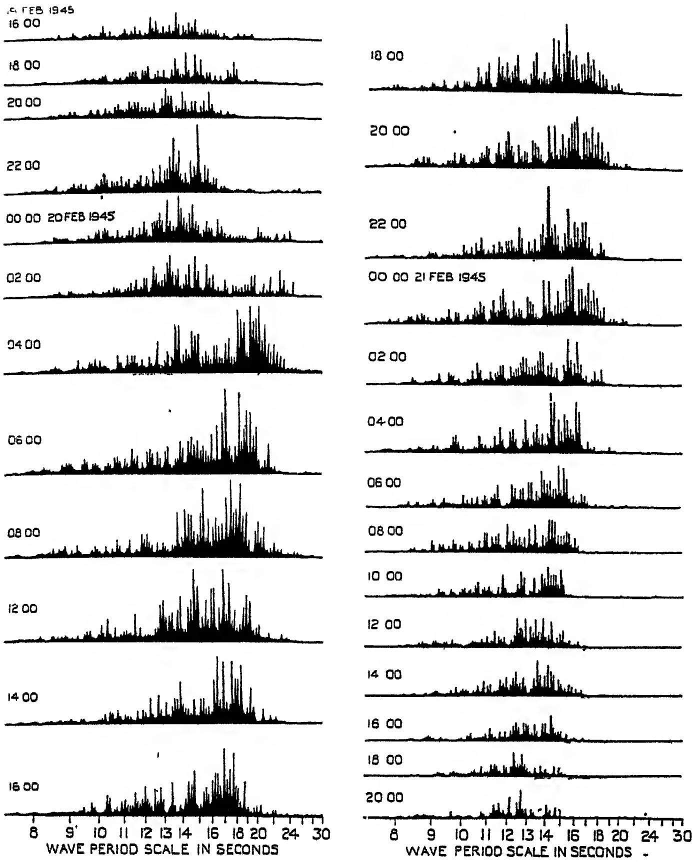

Fig. 6. A SERIES OF WAVE-PRESSURE SPECTRA

galvanometer build up and decay in amplitude as the gliding tone passes through resonance is determined by a parameter k, where $k = \sqrt{a/2pb^2}$.

Fig. 4 shows the response curves of the galvanometer for various values of k. They illustrate in particular the effect of changing the damping of the galvanometer without changing the rate of decay in speed of the wheel. With fairly large damping, $k = 0{\cdot}5$, the galvanometer builds up slowly to a small amplitude of resonance and decays smoothly. With smaller damping the peak is higher and sharper, but the decay is executed in a series of beats. With very small damping the galvanometer builds up to a limiting amplitude and proceeds to beat, but the time of decay of the motion is very long. Taking the effective width of the response as the interval in which the response exceeds 1/10 of its maximum value, it is clear that there is an optimum damping at which the width of the response curve is least. This is approximately at

$$k \text{ (optimum)} = 1{\cdot}8.$$

This optimum value of k gives the greatest resolution of the Fourier components. When the galvanometer is giving its peak response to one Fourier component, it is being slightly affected by adjacent components the gliding tones of which have either not yet reached the natural frequency of the galvanometer or have passed through it. If we consider the components to be adequately resolved when the contribution from each adjacent harmonic is less than 10 per cent of the peak response to that harmonic, it is possible to show from the curves of Fig. 4 that in any given apparatus all the harmonics are resolved up to the Nth, where

$$N = 0{\cdot}12\sqrt{p/a},$$

assuming that the damping b is at its optimum value for the p and a specified. It is clear that an analyser can be constructed to resolve any desired number of harmonics.

For the apparatus at present in use

$a = 0{\cdot}0028$ (decay to $\frac{1}{2}$ in 4 min.)

$p = 750$ (natural frequency 120 cycles);

so that for optimum working at $k = 1{\cdot}8$ we should have

$b = 0{\cdot}001$ (decay to 1/10 in 3 sec.),

and the harmonics are resolved as far as

$$N = 60.$$

At $N = 120$ the adjacent harmonics contribute about 25 per cent of their peaks, and at $N = 240$ they contribute about 50 per cent, so that the peaks merge together. At higher harmonics the mean amplitude of vibration of the galvanometer may be taken as proportional to the square root of the sum of the squares of the amplitudes of the Fourier components in about a 1 per cent range of frequency. Even at high orders of harmonics the apparatus clearly separates isolated frequencies which differ by more than 3 per cent. Fig. 5 shows the analysis of an artificial record producing frequency belts near every 10th harmonic. These belts of frequency are resolved up to about the 400th and 410th harmonic, where the frequencies differ by $2\frac{1}{2}$ per cent. It is difficult to construct simple artificial records which have prescribed amounts of high harmonics, but the analysis of such records has shown that the amplitudes of the Fourier components up to the 60th are correct to 5 per cent; this error might be increased to 10 per cent, when a number of adjoining frequencies are present.

A wheel with mechanical drive and variable, controlled, exponential rate of decay, designed by F. E. Pierce, is being constructed in the workshops at the Admiralty Research Laboratory. With this wheel, which can be rotated up to 10 revolutions a second, more favourable characteristics can be chosen for damping and natural frequency, to allow greater resolution in an analysis taking the same time. Complete instruments are being made by Messrs. H. Tinsley & Co. Ltd.

The propagation of waves away from storm areas has been investigated with this analysis. Rules have been found which will allow improvement of methods of forecasting swell, a subject of interest to harbour and shipping authorities.

Fig. 6 shows a series of Fourier amplitude spectra of pressure at the bottom of the sea at a point off the Cornish coast. It is clear that there is a general trend in these analyses; it will be shown elsewhere that this is consistent with classical hydrodynamicla theory. It is expected that rapid progress will

continue to be made, particularly after a network of recording stations has been established. A general account of the problem has been published by Deacon in "Ocean Waves and Swell", Occasional Publications of the Challenger Society, No. 1, April, 1946, pages 1–13 (see *Nature*, 157, 165 ; 1946).

We are indebted to the Board of Admiralty for permission to publish this article.

THEORETICAL PHYSICS IN INDUSTRY*

By Dr. H. FRÖHLICH

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Free Electrons in Solids

IN considering the behaviour of electrons in crystalline solids, a well-known theorem by F. Bloch is of great importance. According to this theorem, electrons in a perfectly periodic lattice move freely without being scattered. This does not mean, however, that all electrons contribute to the electric conductivity, because this would also require the possibility of accelerating electrons. To investigate this question we notice that the energy spectrum of electrons in a crystal consists of bands which are well separated in the low-energy region but which overlap at high energies. For simple structures each band contains N levels, where N is the number of unit cells. According to the Pauli exclusion principle, each level can be occupied by no more than two electrons. It thus follows that each energy band accommodates $2N$ electrons. The average velocity of all electrons in a completely filled band vanishes. Thus in the energy region in which bands do not overlap, a completely filled band does not contribute to the conductivity, because there are no empty levels into which an electron can be accelerated. This case is realized in insulators at low temperatures, where the highest occupied level coincides with the upper edge of an energy band in the region where bands do not overlap. In metals, on the other hand, there is at least one energy band which is not completely filled.

Consider now an insulator. To produce an electric current, electrons must be lifted into a normally empty band. This transition can be made either thermally, optically or by very strong fields. An electron in one of these conduction bands will be treated as a free electron with kinetic energy E. Such an electron will be scattered by any deviations from a strictly periodic lattice such as temperature vibrations or lattice defects. In view of this scattering, the average velocity $\bar{v}$ of an electron vanishes in the absence of an external electric field. In the presence of a field, electrons are accelerated in the direction of the field. In a very crude picture, one can imagine that each electron is accelerated for a time 2τ, after which it loses its additional velocity. Thus the average velocity of an electron is

$$\bar{v} = eF\tau/m, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and hence the current density is

$$e^2F\tau z/m,$$

where z is the number of free electrons per unit volume. Consider an ionic crystal without lattice defects, so that the scattering is entirely due to the lattice vibrations. These lattice vibrations can be considered as a superposition of polarization waves of various wave-lengths, but with about the same frequency ν. The scattering of an electron is connected with either an absorption or an emission of a quantum $h\nu$. The probabilities for these processes are proportional to n and $1 + n$ respectively, n being the number of quanta of a given wave-length λ present in the lattice. The momentum of such a wave is h/λ, and the scattering angle θ of an electron is determined by the momentum law. Scattering can be considered to be elastic if $E \gg h\nu$. The probability P_θ for scattering by an angle θ is then the sum of scattering processes leading to absorption and emission of a quantum $h\nu$. One finds

$$P_\theta \propto (1 + 2n)/\sqrt{E} \quad . \quad . \quad . \quad . \quad (2)$$

The time of relaxation τ is connected with P_θ by

$$1/\tau = \Sigma(1-\cos\theta)P_\theta, \quad . \quad . \quad . \quad (3)$$

where the sum is taken over all angles θ. The average angle θ depends on the energy of the electron. For electrons of several e-volts one finds

$$\tau \propto E^{3/2}/(1 + 2n) \quad . \quad . \quad . \quad (4)$$

In the theory of conductivity, it is usually assumed that the energy transfer from the field to the electrons, and from the electrons to the lattice vibrations, is of little importance. This is, however, not the case if the number of electrons in the conduction band is so small that their mutual collisions can be neglected. In this case they do not exchange energy, and the rate of energy transfer A from the field to an electron is thus given by $e\bar{v}F$, that is, using (1) and (4)

$$A = e^2\tau F/m \propto E^{3/2}F^2/(1 + 2n) \quad . \quad . \quad . \quad (5)$$

The average rate of loss of energy B to the lattice vibrations, on the other hand, is

$$B \propto \frac{1 + n - n}{\sqrt{E}}, \text{ that is, } B \propto 1/\sqrt{E}, \quad . \quad . \quad (6)$$

because the probability for absorption or emission of a quantum $h\nu$ is proportionally to $n/\sqrt{E}$ and $(1+n)/\sqrt{E}$ respectively. Now so long as B is greater than A, a single electron with energy $E \gg h\nu$ will on an average lose energy at a higher rate than it gains energy. This is reasonable because the Maxwell distribution function exp. $-E/kT$ has its highest value at $E = 0$. From (5) and (6) it follows, however, that B decreases and A increases with E. Thus at sufficiently high energies an electron will on an average gain more and more energy. It will be shown later that this may have important consequences.

A difficulty connected with the motion of slow electrons in ionic crystals concerns the polarization of the crystal near the electron. If ν is the frequency of oscillation of an ion, it will take about $1/\nu$ sec. for an ion to be displaced by the field of the electron. In this time an electron of velocity v moves a distance $r_0 = v/\nu$. This means that only at distances larger than r_0 is the polarization proportional to the Coulomb field of the electron. Hence the energy of polarization depends on r_0. It is of the order $-e^2/r_0 = -e^2\nu/v$. For small velocities this term may become more important than the kinetic energy $mv^2/2$. No detailed study of the influence of polarization on the motion of electrons has been made yet.

Theory of Dielectric Breakdown

Consider a solid dielectric to which an external electric field is applied. If the field-strength inside the dielectric exceeds a critical value, the insulation

* Substance of a course of three lectures delivered at the Royal Institution on March 28, April 4 and 11.

breaks down. This breakdown field is an intrinsic property of the material. In many ways it behaves similarly to the electric resistance of metals, provided the temperature is below a critical value T_c. Thus the breakdown strength increases if foreign atoms are added to a pure substance, or it increases with temperature up to T_c. Both effects are due to the behaviour of the relaxation time τ of electrons of several electron volts. Whereas the electric resistance is proportional to $1/\tau$, the breakdown strength is proportional to $1/\sqrt{\tau}$, as will be shown below.

Let us first derive the above-mentioned properties of $1/\tau$. According to equation (3), this quantity depends on the probability P_θ of scattering an electron by an angle θ. This scattering is due to deviations from a strictly periodic lattice. Both temperature-motion and the presence of foreign atoms lead to such deviations. The former increases with temperature. The latter is temperature-independent but increases with the concentration of foreign atoms. It follows that P_θ is the sum of two terms, $P_{th} + P_f$; and hence, using (3), the inverse time of relaxation too is composed of two terms

$$1/\tau = 1/\tau_{th} + 1/\tau_f \quad . \quad . \quad . \quad . \quad (7)$$

The first term refers to temperature-scattering, that is, it increases with temperature T. (In equation (4), which also refers to temperature-scattering, n increases with T.) The second term is due to scattering by foreign atoms. Thus $1/\tau$ behaves as required by experiment. Actually the increase of breakdown strength F with T was first predicted by theory and then found experimentally.

To show that $F \propto 1/\sqrt{\tau}$, consider the rate of energy transfer A, from the field to an electron, and B, from an electron to the lattice vibrations. We saw in equations (5) and (6) that A increases and B decreases with the energy of an electron. Thus an energy E' must exist where A is equal to B. For $E > E'$, electrons gradually drift to higher and higher energies. Thus a stationary state would seem to be impossible. Actually the above considerations hold only if $E < I$, where I is the energy required for an internal ionization of an ion or atom of the lattice, and the field will produce additional ionization only if $E' < I$. Hence $E' = I$ will be taken as condition for breakdown (it has not been possible to give a more exact derivation of this condition. An exact calculation shows, however, that the possibility of reaching stationary conditions is entirely determined by the behaviour of electrons with an energy $E > I$, which lends support to the condition used above.) Taking $E' = I$, then $(A = B)_{E=I}$, or with (5)

$$e^2F^2 = (mB/\tau)_{E=I}\,; \text{ that is, } F \propto 1/\sqrt{\tau}$$

as required. As a further consequence of this theory thin layers should have a higher breakdown strength than the material in bulk. Actually it was found that a layer of mica of about 10^{-5} cm. thickness has about twice the electric strength of a thick layer.

Experiments on the temperature-dependence of the breakdown strength F show that above a critical temperature T_c the dielectric strength decreases with temperature. It was also found that for amorphous solids T_c is in general much smaller than for crystals. Thus the theory sketched above holds only below T_c. To show that this has to be expected, it should be remembered that the calculation of the rate of energy exchange A and B was based on the assumption that there are so few electrons in the conduction band that their mutual collisions can be neglected. Actually it is known that in strong fields (but below breakdown strength) the number of electrons in the conduction bands is higher than in the absence of a field, and that this number increases with temperature. Thus a temperature will be reached where it is no longer possible to neglect collisions between electrons. To derive a theory of breakdown at this high-temperature region ($T > T_c$) assume that T is sufficiently large to make the density of electrons in strong fields so high that mutual collisions between electrons are much more frequent than collisions between electrons and lattice vibrations. It can then be assumed that the electrons are in a thermal equilibrium, but at a temperature T which is higher than the temperature T_0 of the lattice. Thus energy will flow from the electrons to the lattice at a rate $\overline{B}(T,T_0)$ which can be shown to increase, for small temperature differences $T-T_0$, proportionally to $T-T_0$; but referred to a single electron the rate approaches a finite value as $T \rightarrow \infty$. In equilibrium, this quantity must be equal to the average rate of energy transfer $\overline{A}$ from the field to the electrons. From $\overline{A} = \overline{B}$ the electronic temperature T can be calculated.

A more detailed investigation shows that this is possible only if the field is below a critical value F. For larger fields no equilibrium can be attained, that is, the electronic temperature increases until the crystal breaks down. The temperature-dependence is found to be $F \propto \exp \Delta V/2kT_0$, where ΔV is a constant energy. Thus, for $T > T_c$, F decreases with increasing lattice temperature in agreement with experiment.

Theory of Dielectric Loss

Consider now solids which consist of molecules containing electric dipoles (for example, ice, ketones). If an alternating electric field is applied to such a solid, energy will be transferred from the field to the solid. Let E, P and D be the field strength, polarization and electric displacement respectively,

$$\text{that is,} \quad D = E + 4\pi P \quad . \quad . \quad . \quad . \quad (8)$$

The energy-loss is due to a phase shift of the polarization relative to the field. Thus if

$$E = E_0 \cos\omega t, \quad . \quad . \quad . \quad . \quad . \quad (9)$$

then
$$P = P_1 \cos\omega t + P_2 \sin\omega t \quad . \quad . \quad . \quad (10)$$

It follows from Maxwell's equations that the rate of change of the energy of the electric field is

$$\dot{U} = E\dot{D}/4\pi,$$

or using (8), (9) and (10)

$$\dot{U} = -\frac{E_0}{4\pi}(E_0 + 4\pi P_1)\omega\cos\omega t\sin\omega t + E_0P_2\omega\cos^2\omega t.$$

On an average, over a full period the first term vanishes and thus $\overline{\dot{U}} = E_0P_2\omega/2$. Usually one introduces a complex dielectric constant $\varepsilon = \varepsilon_1 - i\varepsilon_2$. The relation $D = \varepsilon E$ is then understood in such a way that the right-hand side represents the real part of $\varepsilon E_0 \exp i\omega t$. It then follows that

$$4\pi P_2 = \varepsilon_2 E_0, \quad . \quad . \quad . \quad . \quad (11)$$

and hence the dielectric loss is

$$\overline{\dot{U}} = E_0^2\omega\varepsilon_2/8\pi\,; \quad . \quad . \quad . \quad . \quad (12)$$

that is, ε_2 is proportional to the dielectric loss per cycle.

The phase-shift of the polarization which determines the dielectric loss (cf. equations (10), (11), and (12)) is due to the fact that it takes some time to establish equilibrium in an external field. To account for this

phase-shift, consider the dipolar structure of solids. In most cases dipoles have two or more equilibrium positions. They oscillate around one equilibrium position with a frequency $\omega_0/2\pi$, but occasionally they jump into another one. An external field acts in two ways on the dipoles. (i) The dipole direction in the equilibrium positions is changed, and (ii) the distribution of dipoles over the various equilibrium positions is also altered. Let τ_1 and τ_2 be the times required to establish equilibrium for the two cases. Then in the second case, this time, together with the frequency of the field, entirely determine the frequency-dependence of ε_2, which in this case is of the so-called Debye type,

$$\varepsilon_2 \propto \frac{\omega\tau_2}{1 + \omega^2\tau_2^2} \quad . \quad . \quad . \quad . \quad (13)$$

Thus ε_2 has a maximum when $\omega = 1/\tau_2$. In the first case, however, loss is of the resonance type and is determined not only by τ_1, but also by ω_0 :

$$\varepsilon_2 \propto \tfrac{1}{2}\left\{\frac{\omega\tau_1}{1 + (\omega + \omega_0)^2\tau_1^2} + \frac{\omega\tau_1}{1 + (\omega - \omega_0)^2\tau_1^2}\right\} . \quad (14)$$

In this case ε_2 has a maximum when

$$\omega = (1 + \omega_0^2\tau_1^2)^{1/2}/\tau_1.$$

Thus if $\omega_0\tau_1 \ll 1$, both types of loss behave similarly ; but for $\omega_0\tau_1 \gg 1$, the maximum of ε_2 in (14) lies always near ω_0. This second type of loss is expected to be of importance in the region of ultra-short waves, but detailed comparisons with experiments have not been carried out yet. For longer waves the Debye loss gives, in general, a reasonably good description of experiments if one admits the existence of a whole range of relaxation times τ_2. So far, however, in only a few cases has it been possible to calculate the actual value of τ_2 from the structure of the solid.

THE FOOD AND AGRICULTURE ORGANISATION

THE Food and Agriculture Organisation (F.A.O.) of the United Nations, on the invitation of the Interim Commission on Food and Agriculture, held the first session of its Conference at Quebec during October 16–November 1, 1945. The report of the proceedings has now been published*.

With the formal establishment of the Food and Agriculture Organisation, the Interim Commission, which had been in being since the Hot Springs Conference, ceased to exist, and tribute is paid to the high quality of its work, which has provided sound foundations for future developments and greatly facilitated the business of the first session of the succeeding body. At the close of the Conference, membership of the Food and Agriculture Organisation consisted of forty-two countries and in addition four others were represented as observers. Sir John Boyd Orr, well known for his valuable work both in the realms of agriculture and nutrition, has been appointed director-general, and many distinguished specialists with a wide diversity of experience are among the members of the various committees. L. B. Pearson (Canada), as chairman of the first session, writes an introductory letter to the report, explaining the framework of the Organisation, setting forth its aims and calling upon the various governments for the necessary support to implement its recommendations.

The task before the Conference was immense and many of the recommendations are necessarily those of long-term policy. Care has been taken, however, that problems of immediate urgency should not be overlooked, for it is asserted that substantial improvements in production, nutrition and rural welfare could be effected merely by a more energetic application of existing knowledge and facilities.

The avoidance of overlapping between different organisations working in the same field is clearly desirable, and the winding up of the International Institute of Agriculture and the Comité International du Bois in favour of the Food and Agriculture Organisation is recommended. At the same time, the necessity for co-operation with any appropriate national organisation already in existence is repeatedly stressed, and the greatest importance is attached to the representation of the Organisation at all international discussions on commodity arrangements in respect of food and other agricultural products.

The work of the Conference was divided into two parts. Commission A dealt with the broad subject of policies and programmes, and consisted of six committees concerned respectively with nutrition and food management, agriculture, forestry and forest products, fisheries, marketing and statistics.

Commission B devoted its attention to organisation and administration, and was made up of four committees dealing with rules and procedure, finance, administrative arrangements, and constitutional and diplomatic questions respectively.

The reports of the various committees of Commission A leave no doubt as to the need for such a body as the Food and Agriculture Organisation. International co-operation and a linking together of production and consumption, and of industry with agriculture are essential if any solution is to be found for the innumerable problems of the world to-day. The fear of over-production is almost universal among Western farmers, but neither unrestricted competition nor control of output will meet the situation. Only by finding the necessary balance between production and consumption can the danger be removed. In the less developed but densely populated countries, though the immediate need is for agricultural improvements, industries must be developed to provide employment for the surplus population and raise the standard of living. A large proportion of the world's population is undernourished, quite apart from the special problems created by the Second World War, and one of the immediate tasks of the Organisation is to get needed foods to certain vulnerable groups such as young mothers and children. In these poor countries it is suggested that demonstration areas should be set up where educational schemes and food distribution can be carried out, and the production of more protective foods such as milk and vegetables be specially encouraged. Assistance with seeds, fertilizers, machines and advisory services are also a first call on the Organisation's activities in such countries. Further programmes for raising the standard of livestock and crops, irrigation and soil improvement are envisaged in the near future.

The world's undeveloped forests, especially those of tropical regions, present a unique opportunity for the Food and Agriculture Organisation. Besides being

* Food and Agriculture Organisation of the United Nations. Report of the First Session of the Conference held at the City of Quebec, Canada, October 16 to November 1, 1945. Pp. xxi + 89. (Washington, 6 : F.A.O., 2000 Massachusetts Avenue, N.W., 1946.)

the greatest remaining wood reservoir in the world, they produce a great assortment of non-timber and food products. The Organisation is the only existing body that can influence Governments to develop sound policies for their utilization, thus avoiding a repetition of the wasteful exploitation that has so often occurred in the past. To this end a world forest policy is urged, such as has already been considered by the Interim Commission. Besides the direct value of the timber, good forest management has far-reaching beneficial effects. Afforestation can reclaim swampy land, prevent soil erosion, and, provided grazing is controlled, may be an asset in the raising of livestock; in fact, over large areas afforestation is a pre-requisite to better agriculture and improved rural living standards.

Up to the present, there has been no world-wide organisation of fisheries, and the collection of information regarding world production and markets and the setting up of statistical surveys are pressing demands on the Food and Agriculture Organisation. Normally more than ninety per cent of the world's fish is caught in the North Atlantic and North Pacific Oceans, but, during the War, fishing grounds have been developed by South American countries and could probably be extended elsewhere. Freshwater fish, too, might be a valuable asset in districts where livestock industries cannot easily be developed and the diet is likely to be deficient in protein. Conservation measures are of importance in the old fisheries, and in view of the varied nature of the problems in the different areas, it is suggested that international action should be established on a regional basis.

Marketing affects all commodities, and the economic adjustment of international markets is perhaps the most crucial problem that confronts the Food and Agriculture Organisation. The under-developed countries need advice and help on the technical side of modern marketing, whereas simplification in methods of distribution is the prior call in the more advanced countries. Measures for international co-operation on matters of food infestation, standardization of grades, nomenclature, etc., will need working out, and machinery designed to deal with shortages and surpluses. The improvements in methods of processing and storage developed during the War should prove of particular benefit in the latter case.

In all these fields statistics form an essential background, and there is urgent need for the continuation and extension of international records relating to agriculture, forestry, fisheries and food consumption. Uniformity in definition of terms, together with the use of comparable techniques for the collection of data, are urged, and the formation of a central statistical unit servicing all the activities of the new Organisation is suggested.

The need for a central library, or possibly of several regional libraries, is evident, and it is hoped that the agricultural library of the International Institute of Agriculture will be available as a nucleus for the Food and Agriculture Organisation.

The documents and resolutions appended to the report are impressive evidence of the work of Commission B. They comprise a set of rules of procedure, a set of permanent and temporary financial regulations, and a budget for the first two financial years. On this Commission's recommendation, the Conference decided to continue the temporary seat of the Organisation at Washington, and to establish the permanent seat at that of the United Nations, assuming that this would also be the seat of the Economic and Social Council.

In signing the constitution of the Food and Agriculture Organisation, governments have undertaken to make periodic reports to the director-general on progress achieved in the fields of nutrition, agriculture, forestry, fisheries and rural welfare. These will provide the information from which further advice and recommendations can be given—in fact, the Organisation will be useful to the extent which it is used. In the words of the chairman, "The first of the new permanent United Nations agencies is now launched. . . . The Conference hopes that it will likewise be first in energy and in usefulness, so that it may make the maximum contribution possible to healthier and more abundant life, and to a peace built on day-by-day, practical co-operation among the peoples of the world."

NEWS and VIEWS

Prof. R. T. Leiper, C.M.G., F.R.S.

The title of emeritus professor of helminthology has been conferred by the University of London upon Prof. R. T. Leiper, who is retiring from the William Julien Courtauld chair of helminthology. When he went to the London School of Tropical Medicine (which later amalgamated with the London School of Hygiene) Leiper set himself to organise the courses of instruction in helminthology which have been so valuable to medical men taking postgraduate courses and to others who have been able to attend them. Leiper was also director of the Institute of Agricultural Parasitology at Winches Farm, St. Albans. To his inspiration and wise guidance we are largely indebted for the series of researches done at this Institute upon the nematodes which do so much harm to valuable crops and also upon the nematodes and other helminths which attack farm animals. Winches Farm, now well known wherever parasitology is studied, is also the home of the Imperial Bureau of Agricultural Parasitology, the services of which to research workers and to others can scarcely be under-estimated. Leiper also founded and edited the *Journal of Helminthology*, which was, until it became necessary, during the recent War, to discontinue it, one of the very few British journals devoted entirely to parasitology. Prof. Leiper's own researches take us back some forty years, when he began to publish the long series of papers in which his work is recorded. Outstanding among these papers is the record of his work on the life-histories of the human blood-flukes, *Schistosoma hæmatobium* and *S. mansoni*. When Japanese workers worked out the life-history of *Schistosoma japonicum*, which causes human schistosomiasis in Japan and adjacent areas, Leiper set to work in Egypt and demonstrated that *S. hæmatobium* and *S. mansoni* are different species, which employ as their intermediate hosts different species of snails. He thus laid the biological foundation of our present extensive know-

ledge of the biology and control of the forms of schistosomiasis caused by these two species of *Schistosoma*. Throughout his tenure of the Courtauld chair of helminthology, Prof. Leiper's advice and help were continually sought and generously given. He was a member of many committees and advisory bodies and exercised, as an adviser to these and to the Agricultural Research Council and other Government organisations, a widespread influence.

British Electrical and Allied Manufacturers' Association: Mr. Bruce H. Leeson, O.B.E.

Mr. Bruce H. Leeson, managing director of A. Reyrolle and Co., Ltd., has been appointed director of the British Electrical and Allied Manufacturers' Association as from October 1, in succession to Mr. V. Watlington. Mr. Leeson was responsible for the formation of the Technical and Research Department of Messrs. Reyrolle, with particular reference to the switchgear and protective gear upon which that firm specializes. He was intimately connected with the establishment of the first short-circuit testing station in Britain in 1929, and afterwards with the standardization of switchgear performance, and the formation of the Association of Short-Circuit Testing Authorities and the negotiations with the National Physical Laboratory, under the auspices of which it operates. Mr. Leeson has been actively interested in establishing anew the north-east coast of England as a development area for industry. Since their inception, he has taken a practical executive interest in three important local bodies: the Northern Industrial Group, which encourages industry and employment in the whole district; the North-East Development Association, which co-ordinates all efforts for the benefit of the area; and the North-East Engineering Bureau, which aims at progress in light and allied engineering.

British Iron and Steel Research Association: Dr. M. L. Becker

Dr. M. L. Becker, chief metallurgist to the Gear and Tool Divisions of Messrs. David Brown and Sons (Huddersfield), Ltd., has been appointed superintendent metallurgist to the British Iron and Steel Research Association. Previously he was on the staff of the National Physical Laboratory. Dr. Becker studied at the Universities of Sheffield and Manchester, and for a time was with the British Cast Iron Research Association. He has been closely associated with the iron and steel industry, having undertaken research on gaseous equilibria, alloys of iron, spring steels, materials for high-temperature service and many allied problems. Latterly his interests have been primarily in the use of steels and alloys in engineering, and in this connexion he has been concerned with the development of works processes of gas carburizing and of flame and induction hardening.

National Coal Board: Chief Mining Engineer

The National Coal Board has appointed Prof. Douglas Hay to be chief mining engineer to the Board. Prof. Hay is president of the Institution of Mining Engineers and honorary professor of mining in the University of Sheffield. He is at present managing director of Barrow Barnsley Main Collieries, Ltd., and the Barnsley District Coking Company, Ltd., also technical director of the Wombwell Main Company, Ltd. He was H.M. Inspector of Mines for Durham and North Staffs during 1920–22; and professor of mining in the University of Sheffield during 1922–25. He has been consulting engineer on ventilation of the Mersey Tunnel (1929–37) and Dartford Tunnel since 1937.

Roman Remains in Exeter

Results of exceptional interest for the study of Roman Britain have been obtained by the Committee excavating on war-damaged sites in the city of Exeter. The work has been carried out under the direction of Lady Fox. According to a preliminary report (*The Times*, August 21) two houses of the period of the first occupation by the Romans of what is now Exeter were discovered in ground to the east of the Lower Market. They were built in a framework of wooden uprights, six inches in diameter, and driven deeply into the ground. These two structures stood one on either side of a narrow metalled roadway with a central channel to carry off surface water to the Exe. It was possible to construct a nearly complete plan of one of the houses, which showed that it had consisted of one large room, 36 ft. by 22 ft., an adjoining kitchen or work chamber and a narrow annex. The floor of the principal room was of clay, which had been kept sanded; the walls were probably of horizontal boarding or of wattle and daub. There was a fireplace of red tiles in the centre. In the annex were Samian and pre-Flavian pottery, which fix the date at *circa* A.D. 55–75, and mingled with these, fragments of coarse native ribbed ware which point to the persistence to this relatively late date of an early Iron Age ware—a somewhat remarkable survival. At about A.D. 80 these buildings were demolished to make an open space, thought to have been the court of the Forum. The importance of this part of the Committee's results will readily be appreciated since they will help very considerably to throw light on the little-known urban life at this early stage of the Roman occupation.

Archæological Work in Southern Mexico

After four months of field work near San Lorenzo, Veracruz State, in southern Mexico, on the third of a group of important centres of the La Venta culture, a joint archæological expedition of the National Geographic Society and the Smithsonian Institution, led by Dr. Matthew W. Stirling, has returned to Washington. The season's activities mark the conclusion of eight years of work by Dr. Stirling. The inquiries began in 1939 with the uncovering of a huge basalt sculpture in the form of a human head, near Tres Zapotes, a village in Veracruz State. The site proved to have been a ceremonial centre marked also by earthen mounds. One of the most important discoveries during the series of expeditions was made at Tres Zapotes in 1939—an inscribed stela bearing in Mayan characters the earliest recorded date, believed to be contemporary, so far brought to light in the western hemisphere. The date has been interpreted as 291 B.C. according to the Spinden correlation or 31 B.C., Thompson correlation. In the following year, Dr. Stirling and his associates began excavations at the site of La Venta, Tabasco, so rich in monuments and artefacts that it has given its name to the newly discovered culture. La Venta, unlike the other two ceremonial centres, was a place of burial for important personages among the La Venta people. The San Lorenzo site, worked in 1946, is the farthest inland of the three sites excavated. It lies about sixty miles from the Gulf of Mexico on the Rio

Chiquito. It is also the most extensive of the centres, and there, apparently, the sculpture of the La Venta culture reached its highest development. The five huge heads discovered are for the most part better made, better preserved, and bigger than those from the other locations. Some of the heads are nearly ten feet high and are estimated to weigh more than twenty tons. It seems that the La Venta culture at Tres Zapotes started about A.D. 300 and lasted there until about A.D. 1000. The La Venta and San Lorenzo sites apparently were developed later and abandoned earlier. The correlation of art forms and pottery types points to the probability that the La Venta culture was a forerunner of much of the culture of the Mayas, the Toltecs and the Aztecs.

Prehistoric Studies in Austria during the War Years

THE war-time "Mitteilungen des Prähistorischen Kommission der Akademie der Wissenschaften, Wien" are now to hand. There are five reasonably stout volumes and one (1942) much reduced. They cover the years 1939–44 inclusive. The first volume, the work of A. Hild, is concerned with the grave finds from Bludenz (Vorarlberg), which date from about 1000 B.C. and after. As always in the case of these publications, there are a number of excellent illustrations at the end of the volume. Adam Graf Orssich de Slavetich describes, in the 1940 volume, a site called Bubanj near Nish (Jugoslavia). Here the finds are somewhat earlier in date and can be compared with the early Vinča material. Some of the illustrations of the pottery are in colour, and there is a map. In the 1941 volume, E. Beninger deals with an early Bronze Age site at Gros-Mugl, Niederdonau, while the short 1942 volume (by Christian Pescheck) describes a late Hallstät find from Donnerskirchen, Niederdonau. The 1943 volume deals with grave finds of a similar date from Krensdorf and is by J. Tomschik, while the last volume (1944) is concerned with early Metal Age tumulus finds at Mühlhart, near Fürstenfeldbruck, Upper Bavaria. It is good news to learn that archæological interest in Austria was not quite dead throughout the war years. The volumes noted above are, of course, important for all students interested in the archæology of the periods covered.

Guide to Cultural Materials

WHEN visiting outlying parts of the world, it sometimes happens that opportunity arises to study a folk who are still in a primitive stage of culture, whose ideas, social customs and implements are very different from what we are used to see among more civilized races. In order to make good use of such an opportunity, it is necessary to know in advance what to look for and what questions to ask, so that the maximum amount of information can be obtained. Vol. 2 of the Yale Anthropological Studies entitled "Outline of Cultural Materials" (New Haven: Yale Univ. Press; London: Oxford Univ. Press. 6*s*. 6*d*. net), which has been prepared by G. P. Murdock, C. S. Ford, A. E. Hudson, R. Kennedy, L. W. Simmons and J. W. M. Whiting, sets out under various headings and in convenient form just what is needed in this respect. An index is appended.

Antiquity of Man

PROF. H. BREUIL has recently delivered the Huxley Memorial Lecture of the Royal Anthropological Institute for 1941 (from the Institute, 2*s*. 6*d*.). The delay, of course, was consequent on the War. His subject was "The Discovery of the Antiquity of Man". A useful historical retrospect occupies several pages, after which the geological and palæontological situation is considered. Prof. Breuil has not attempted to bring forward new matter; but stands back, as it were, for a moment and takes stock of the edifice of knowledge on this subject already erected.

Coal Gas and Fuel Industries at the University of Leeds

HEALTHY collaboration between a university department and industry is recorded in the report of the Livesey professor (Dr. D. T. A. Townend) on the work of the Department of Coal Gas and Fuel Industries, University of Leeds. There are now, in the Department, eighty-four undergraduate and post-graduate students catered for by a teaching staff of ten. In addition, there are twenty-one research fellows and assistants provided by the Joint Research Committee of the University of Leeds and the Gas Research Board, the Alloy Steels Research Committee, the Department of Scientific and Industrial Research and other Government departments. It is impossible in chemical engineering and many other branches of applied science to conduct research entirely in the laboratory; full-scale or semi-scale plant must be used. It is always difficult, and often impossible, to provide such plant in universities. If these sciences are to prosper in Great Britain, university departments must be given facilities by industry. Prof. Townend has been most successful in obtaining the necessary access to industrial plant. Experiments have been carried out on semi-scale plant, at works of the Bournemouth Gas and Water Co., on the gasification of coal in hydrogen at high pressures and temperatures. Preparations have also been in progress at Bournemouth for large-scale testing at high and normal pressures of the control techniques, devised in the laboratory, involved in the synthesis of methane from carbon monoxide and hydrogen. Semi-scale plant has also been installed, for other purposes, at the Leeds gasworks. The rapid expansion in the work of the Department has, in addition, necessitated further laboratory facilities. The University had included in its post-war planning scheme provision for new buildings, and it is to be congratulated on the recent generous gift by Mr. Charles Brotherton of £55,000 for a new Chemical Engineering Laboratory. It is largely due to his help in this and other directions that a full chemical engineering curriculum has been put into effect so rapidly.

Agrarian Reconstruction in Italy

ANTONIO DONÀ DALLE ROSE has an article in *Ricerca Scientifica e Riconstruzione* (Rome) on this subject in which he summarizes and discusses the scope of the Italian-American Agrarian Convention, held at Florence during January 25–28. Among the proposals may be noticed the provision of a close collaboration among agrarian technicians—American and Italian—and it is pointed out that there would be a mutual advantage in such collaboration. In addition, there should be a close inquiry into the question relating to fundamental alterations in the agrarian industry with a view to an enhanced output. Finally, the bases of reconstruction should be clearly delineated. The subject is discussed at length in the article, and various suggestions are put forth under such headings as the necessity of American agriculture, the method of technical reconstruction and the economic position of Italian agriculture, animal

husbandry in relation to the problem of the shortage of forage, and various others. Finally, the delicate question of emigration is briefly referred to, and reference is made to a suggestion that there might be a large emigration of Italian workers into Latin America. Such emigration should be properly organised so that workers, technicians and directors of industry would find scope for their enterprise and be able to enjoy a full autonomous existence under the authority of the country receiving them.

Scientific Equipment made in Egypt

DR. H. E. HURST, of the Physical Department, Ministry of Public Works, Egypt (*J. Sci. Instr.*, 23, 134; 1946), has given a brief but interesting account of the 100,930 articles made for the British Army in the departmental workshop during the period September 1940–January 1946. The workshop, of moderate size, normally deals with the repair of scientific instruments and the occasional construction of research apparatus used in the study of the Nile. With machinery loaned by the British Army, the equipment of the workshop was doubled. Other machines for special purposes were improvised out of scrap. Ultimately, there were 120 workmen of all sorts working in a fairly well-equipped workshop. A list, giving the number and description of the articles accepted by the Army, includes sun compasses, protractors and scales, stereoscopes, slide rules, small tools and fuses.

American Philosophical Society: Year Book for 1945

THE Year Book for 1945 of the American Philosophical Society, covering the year January 1, 1945–December 31, 1945, includes as usual the minutes of the meetings and of the executive sessions, together with the reports of standing committees, that on research containing classified reports from recipients of grants. Among these may be mentioned the following: R. N. Jones on factors influencing the ultra-violet absorption spectra of aromatic compounds; E. J. Schremp on the fine-structure pattern of directional cosmic ray intensity; S. Ochoa's studies on respiratory enzymes; W. J. Eversole's investigation of the relation of carbohydrate-deficient diets to the effectiveness of hormones of the adrenal cortex; H. J. Muller on age in relation to the frequency of spontaneous mutations in *Drosophila*; S. McGregor Pady on the biology of *Melanosporella*; R. Beutner and T. C. Barnes on a general explanation for the therapeutic action of the drugs which act on the nervous system; R. P. Forster on the effect of general anæsthetics on renal function in the rabbit; I. M. Korr on the relation between tissue metabolism and physiological activity and O. Meyerhoff's studies on intermediary enzymatic reactions of carbohydrate breakdown.

The feature of the report is the appreciation appended to the report of the Committee of the Library, on certain accessions during the year. These include an evaluation of thirty-three unpublished letters from Benjamin Franklin, written during the years 1753–67, by C. Van Doren, who is editing them for publication; a detailed account of the C. W. Peale papers by Mr. C. C. Sellers, and a note by Z. S. Harris on American Indian linguistic work and the Boas Collection, which has now been transferred to the Library. Notes by W. E. Lingelbach on Franklin and the Lewis Evans Map of 1749, by F. Harper on proposals for publishing Bartram's "Travels" and by S. Adelman on equipping the Lewis and Clark expedition originated by Thomas Jefferson in 1801 help to give exceptional general interest to this annual volume.

Society for Psychical Research

THE Society for Psychical Research has issued a pamphlet describing its work (31 Tavistock Square, London, W.C.1. Pp. 20. 3*d*.). It is not generally realized that the Society is a scientific society with a history of more than sixty years work. It originated with a distinguished group of trained thinkers in the University of Cambridge who were interested in the problem of those mental phenomena which appeared to fall outside the recognized laws of mental life. The Society sets out to examine phenomena of this class in a scientific spirit, and has during its existence collected and sifted evidence for and against: (1) the acquisition of knowledge without the use of the ordinary channels of sense, (2) communications purporting to come from the dead, (3) certain types of physical phenomena alleged to occur in the presence of a particular type of medium. The fact that some phenomena are apparently contradictory of recognized scientific laws is not in itself an adequate reason for thinking them to be unworthy of study. Already a considerable body of research exists concerned with telepathy, clairvoyance, the relation of such conditions to psychotherapy and the problems of survival. Modern methods of statistical analysis have proved of great value in the interpretation and arrangement of data. The Society is not concerned with mere trickery or trivial anecdotal evidence; but aims at trying to understand, in the interests of truth, phenomena which, if eventually proved, will have an important bearing on our concept of personality.

Announcements

THE British Association has arranged a Conference on London Traffic and the London Plan which will be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, on September 12–13, when experts will speak on the general problems of traffic, town planning and architecture, and on the special problems of roads, railways, underground railways and travel by air. The Conference will be open free of charge to the public. Further details can be obtained from the office of the British Association at Burlington House, Piccadilly, London, W.1.

THE Fuel Economy Conference of the World Power Conference will be held at The Hague during September 2–10, 1947. During this Conference, an official visit of two days will take place to the Netherlands State Coal Mines at Lutterade. Further information can be obtained from the British National Committee, World Power Conference, 36 Kingsway, London, W.C.2.

THE Dunlop Rubber Co. is contributing £350 net per annum for seven years to the Department of Colloid Science in the University of Cambridge for research work on molecular structure. For the past two years the Department has been carrying out research work for the Dunlop Co. on the structure of natural and synthetic rubber molecules, and the changes occurring in vulcanization. The research will continue under the direction of Dr. G. B. B. M. Sutherland. The work under the new scheme will probably also include ultra-violet and ultra-short-wave radio technique.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Circular Polarization of Solar Radio Noise

In two recent communications to these columns[1,2] we have reported the existence of powerful radio emissions in the 5-metre wave-length band from sunspot areas. Since such radio waves must travel through regions of considerable ionization in escaping from the sun, it occurred to us that the magneto-ionic theory of radio wave propagation[3], which has proved so useful in elucidating phenomena in the terrestrial ionosphere, would be applicable in the case of the corresponding solar envelope. According to this theory, characteristic polarizations are imposed on radio waves in their transmission through an ionized medium under the influence of a magnetic field, due either to differential absorption of the oppositely polarized magneto-ionic components or to the suppression of one component by electron limitation. Such effects are most pronounced if the radio wave frequency in question is either of the same order as, or less than, the electronic gyro-frequency determined by the imposed magnetic field. There is also the possibility that the noise itself has a magneto-gyric (electronic) origin.

Prompted by considerations of this kind, the state of polarization of solar radio noise was examined experimentally, on a frequency of 85 Mc./s., at the Operational Research Group Station of the Ministry of Supply during the recent period of sunspot activity (July 27 and 28, 1946). The polarization was, on that occasion, found to be circular, and of left-handed sense (viewed looking forward along the direction of propagation). This result is clearly connected with the local magnetic field in the vicinity of, and radially outwards from, the sunspot area itself, and indicates still one more example of the way in which radio wave phenomena may be used in the investigation of solar events.

E. V. Appleton
J. S. Hey

Department of Scientific and Industrial Research,
Park House, 24 Rutland Gate,
London, S.W.7.
Aug. 23.

[1] Appleton, *Nature*, **156**, 534 (1945).
[2] Hey, *Nature*, **157**, 47 (1946).
[3] Appleton, *J. Inst. Elect. Eng.*, **71**, 645 (1932).

Solar Radiation on 175 Mc./s.

Appleton[1] and Hey[2] have directed attention to the fact that radio-frequency energy, with some of the characteristics of random 'noise', is emitted with greatly increased intensity from the sun under the conditions of violent disturbance associated with a large sunspot. These observations were confined mainly to the region of frequencies near 60 Mc./s.

Pawsey, Payne-Scott and McCready[3], who have made observations on 200 Mc./s., suggested that radiation of this type is also observable under less disturbed conditions.

In order to investigate other aspects of this phenomenon, we have constructed a device which automatically records and measures the 'noise' received on 175 Mc./s., and which has a sensitivity such that a power of 3×10^{-15} watts (approximately 1 per cent of the receiver noise power) can be detected. This sensitivity corresponds to a thermal energy temperature of 30° K., and it has been possible to record the 'noise' received from the galaxy on a small broadside aerial consisting of eight half-wave dipoles.

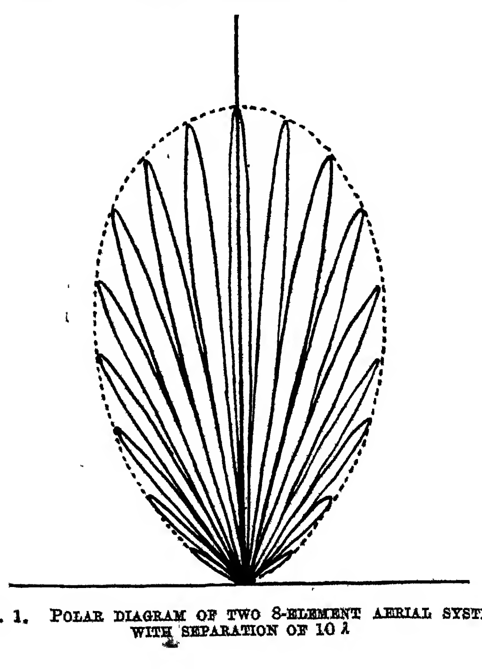

Fig. 1. Polar diagram of two 8-element aerial systems with separation of 10 λ

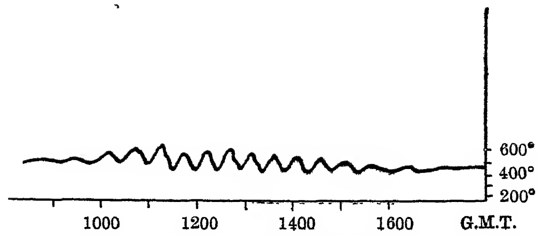

Fig. 2. Record obtained with 10 λ separation (July 17, 1946)

For the purpose of investigating solar radiation under conditions of low solar activity, it is necessary to discriminate against the background of galactic radiation. While this could be achieved by building an aerial to give a sufficiently narrow beam, a very large structure would be required, and observation would be restricted to a short time every day unless arrangements were made for moving the polar diagram of the aerial. An alternative method was therefore used, analogous to Michelson's method for determining stellar diameters. Two aerial systems were used with a horizontal separation of several wave-lengths, and their combined output was fed to the receiving equipment. Such an arrangement produces a polar diagram of the form shown in Fig. 1 where the angle between zeros is governed by the spacing of the two aerials and the envelope is determined by the polar diagram of each individual aerial system. If the angle between minima is sufficiently large compared with the solar angular diameter, then, as the aerial polar diagram is swept past the sun by the earth's rotation, any radiation from the sun should be recorded as an oscillatory trace.

Fig. 2 shows a typical record obtained with an aerial separation of 10 λ, and with only slight solar activity (July 17). The oscillatory contribution due to radiation from the sun can be seen superimposed on the slowly varying background of the galactic radiation. Records of this type enable an estimate to be made of the level of solar radiation even when it is only about one quarter the galactic contribution, and at the present time we have found that the sun is usually sufficiently disturbed to give such records. The power is indicated on the diagram in terms of an 'equivalent aerial temperature', and is the power which has to be fed to an aerial in a black-body enclosure of this temperature, to maintain equilibrium. The temperature of a distant source whose radiation obeys a black-body distribution may be estimated from the observed equivalent aerial temperature by correcting for the ratio of solid angles of source and aerial polar diagram.

During the appearance of a large sunspot between July 20 and August 1, the solar radiation was much increased, and the opportunity was taken to use the apparatus to determine the angular diameter of the source, by observing the ratio of maximum to minimum intensity as the polar diagram of the two aerials with a separation of many wave-lengths was swept past the sun. This experiment was carried out with a series of different aerial spacings, the final value being 140 λ, and a sample of the records obtained with this spacing is shown in Fig. 3. The maximum/minimum ratio obtained under these conditions corresponds to a source diameter of 10 minutes of arc. Any inequalities in the two aerial systems would result in an over-estimate of diameter, and this is therefore a maximum value.

Since the value obtained does not greatly exceed the diameter of the visual spot, it is reasonable to relate the source of this radiation with the visual spot itself, or a region closely associated with it.

During the afternoon of July 25 the observed intensity attained a value which would correspond, in the case of black-body radiation from a source of this diameter, to a temperature greater than $2 \cdot 10^{9}$ ° K.

Since the existence of such temperatures in a region from which radiation of this wave-length would escape seems improbable, we considered that the radiation was non-thermal in origin, and the possibility of ordered electron motion was therefore investigated by an examination of the polarization of the radiation. This was carried out by arranging the two aerial systems of the 'Michelson' device to be polarized in planes at right angles to each other. If the radiation were emitted by a completely random 'thermal' source, the two perpendicularly polarized components would not be phase-coherent and no interference effects would be observed. The existence of interference effects would show the presence of phase coherence, and hence prove that the radiation was not of 'thermal' origin. Further, by noting

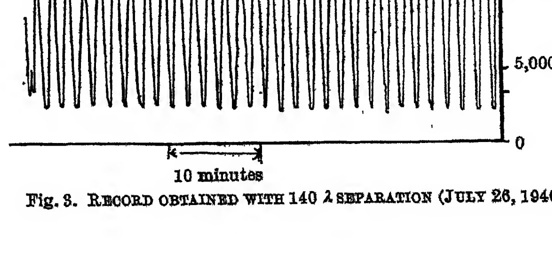

Fig. 3. Record obtained with 140 λ separation (July 26, 1946)

the direction of the sun relative to the aerial systems when an interference maximum was produced, it would be possible to differentiate between plane and right- and left-handed circular polarization.

Using such a system it was found that during periods of intense radiation the polarization was, within the accuracy of measurement, completely circular. (Inequalities in the aerial system limit the accuracy, but at least 90 per cent of the incident energy was circularly polarized.)

Measurements taken over the period July 27–August 3 showed the polarization to be anti-clockwise, viewed along the positive direction of propagation (left-handed). Between August 3 and August 7 the degree of polarization diminished, being virtually completely random on August 7. On August 8, 40 per cent polarization was observed again, but with right-handed polarity—the result, presumably, of increased activity in a subsidiary sunspot.

Any theory of the emission of circularly polarized radiation from sunspots must presumably be given in terms of the magnetic field known to be present in those spots. In considering the mechanism of such a process account must be taken of the magnetic field and electron density not only in the region appropriate to the observed frequency, but also in the overlying layers, where selective absorption of the radiation will occur, in a manner similar to the 'gyro-magnetic' phenomena familiar in the terrestrial ionosphere.

It will be necessary to collect more experimental data before possible theories can profitably be considered in detail.

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Origin of Solar Radiation in the 1–6 Metre Radio Wave-length Band

THE intensity of the solar radiation in the wave-length region of a few metres sometimes deviates extraordinarily from that for a black body at 6000°. The observed departures show a clear correlation with sunspots and their heliographic positions, and become extremely high during the appearance of chromospheric eruptions[1]. As can be shown, even the intensity of the corona, which will radiate in this spectral region nearly like a black body at 10^6 degrees, falls short of the observed values.

If we take account of the influence of the magnetic field of sunspots on the radiating layers, every free electron revolving in the magnetic field H becomes a transmitter, permanently emitting the frequency $\nu = eH/2\pi mc$, or the wave-length $\lambda = 2\pi mc^2/eH = 1{\cdot}07 \times 10^4/H$ cm. At the earth's distance r, such a transmitter produces an electrical field-strength E given by

$$E_\nu^2 = \left(\frac{e^2}{mc^2}\right)^2 \frac{v^2}{c^2}\frac{H^2}{r^2} = \frac{\sigma^2}{r^2}\frac{v^2}{c^2}H^2$$

where v is the thermal velocity and σ the radius of the electron. For a direction of observation parallel to the magnetic field, the radiation is circularly polarized, and for one perpendicular to the field it is plane polarized.

Let the terrestrial receiver have the band-width $\Delta\nu$; then since $\Delta\nu = (e/2\pi mc)\Delta H$ we have

$$\Delta N = \frac{\pi R_0^2 \bar{n}}{dH/dz} \cdot \frac{2\pi mc}{e} \Delta\nu$$

electrons contributing to the emission of the radiation received. $\bar{n}$ is here the mean density of the electrons, πR_0^2 the cross-section of the radiating layer ($R_0 \ll$ solar radius $r_\odot$), and dH/dz the gradient of the magnetic field in the direction of observation. If we express the received field-strength in units of the field produced by the total photosphere (assumed to radiate like a black body at 6000°), and if we take account of the fact that the resultant field strength due to ΔN electrons oscillating with arbitrary phases is proportional to $\sqrt{\Delta N}$, we get for the ratio of the squares of the field-strengths, that is, for the ratio of the intensities,

$$\frac{E_\nu^2 \text{ (electrons)}}{E_\nu^2 \text{ (photosphere)}} = i = \pi^2 \frac{T_e}{T_\odot}\left(\frac{R_0}{r_\odot}\right)^2 \frac{\bar{n}e}{dH/dz}$$

where T_e is the temperature of the electrons. The gradient dH/dz depends in the neighbourhood of a spot essentially on the structure of the current-system induced in the electrically conducting solar atmosphere; it will have an upper limit given by the criterion of mechanical stability of the current-bearing layer

$$\frac{1}{4\pi}\frac{dH^2}{dz} \leq \rho g_\odot$$

where ρ is the mass-density of the layer and $g_\odot$ the gravitational acceleration of the sun. For the inner corona, if we take

$$\bar{n} \approx 5 \times 10^8 \text{ cm.}^{-3},\ T_e/T_\odot \approx 170,$$

and use a projected area of the radiating layer of

$$(R_0/r_\odot)^2 \approx 10^{-3},$$

we obtain values for i of

$$i \lesssim 10^4.$$

This seems to be of the right order. If the distribution of the magnetic field is favourable, the contribution of chromospheric eruptions

$$(\bar{n} > 10^{10}/\text{cm.}^3,\ T_e/T_\odot \gg 1)$$

and spot-type prominences

$$(\bar{n} \approx 10^{10}/\text{cm.}^3,\ T_e/T_\odot \gtrapprox 2)$$

may be still greater!

Re-absorption of the radiation by free-free or free-bound transitions under the influence of the magnetic field, as well as by resonance scattering of electrons revolving in this field, comes out as unimportant.

Taking account of the distribution of the magnetic field and the electron-density, over a spot, it can be shown that the emission is greatest normal to the spot. This agrees with the observation that the intensity is greatest if sunspots are passing the central meridian.

It can also be shown that the total intensity of the corona in the metre-band would be about 10^8 times that of the photosphere, if there were a magnetic field of about 50 gauss. The non-observation of this intensity seems to constitute an independent proof of the shielding of the general magnetic field of the sun.

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The Lower Curie Point of Ferro-electric Salts

COMPARATIVELY little attention has been given to the behaviour of the group of ferro-electric salts analogous to potassium dihydrogen phosphate (KH_2PO_4) at the so-called 'lower Curie point'. In this region dielectric measurements in an alternating field show a rapid decrease in the magnitude of the reversible polarization with decreasing temperature[1]. There has been indirect evidence that this can be attributed simply to the sharp rise in the coercive field, itself unexplained, which has been observed to accompany it, and that the domains of the crystal retain their high spontaneous polarization at lower temperatures. This concept of the 'freezing-in' of the electric moment has been supported by the lack of a specific heat anomaly as observed in this salt[2], and in the case of potassium di-deuterium phosphate by the constancy of the saturation polarization as inferred from electro-optical measurements[3], and by the absence of any change detectable by X-ray analysis; an angular deformation has been clearly shown by this method to accompany the onset of spontaneous polarization at the upper Curie point[4]. While in the Rochelle salt group the lower Curie point corresponds to a real disappearance of the spontaneous polarization[5], no direct experimental evidence exists in any published work for the potassium dihydrogen phosphate group of ferro-electric salts.

An investigation has been made by a static method, in which a measured charge is supplied from a compensating condenser of much larger capacity in order to maintain a fixed potential difference across a crystal of potassium dihydrogen phosphate while its temperature is altered; it has been possible by this means to show that in a constant field the electric moment of the salt is unchanged on passing through the 'lower Curie point'. At the upper Curie point the growth of spontaneous polarization can be followed, and agreement obtained with the values observed in measurements of the electric hysteresis.

Such D.C. measurements have to take account of conductivity of the order of 10^{-10}–10^{-12} ohm^{-1} cm.$^{-1}$, and Fig. 1 shows an example of one type of observation. An electrometer triode bridge is normally employed as a null indicator of correct compensation; but in the case illustrated, chosen for the completeness of the set of relevant observations, the balance of the bridge was influenced by slight but reproducible imperfections of insulation. The conduction current was almost equal to that from two other sources, so that the floating condenser plates and the attached grid tended towards an equilibrium potential, and the galvanometer deflexion slowly approached a limiting position.

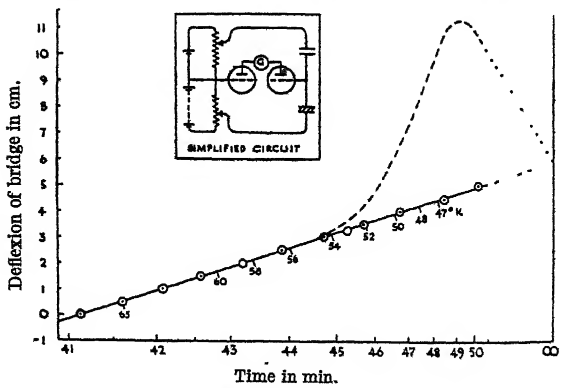

Fig. 1. DEFLEXION-TIME RELATION SHOWING CONSTANCY OF POLARIZATION OF KH_2PO_4 IN CONSTANT FIELD AT THE LOWER CURIE POINT
BROKEN LINE REPRESENTS EXPECTED RELATION ON THE ASSUMPTION OF A REAL DROP IN POLARIZATION EQUAL TO THAT DERIVED FROM THE HYSTERESIS LOOPS

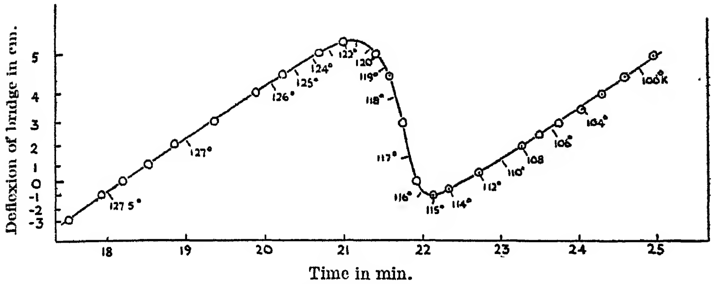

Fig. 2. DEFLEXION-TIME RELATION SHOWING EFFECT OF GROWTH OF POLARIZATION IN KH_2PO_4 AT UPPER CURIE POINT IN CONSTANT ELECTRIC FIELD

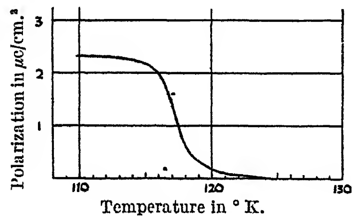

Fig. 3. DERIVED POLARIZATION – TEMPERATURE RELATION

The linearity of this drift over a small range, when plotted on an inverse exponential time-scale, is thus a justifiable criterion of the constancy of the polarization and conductivity of the crystal. The rate of drift is seen to have been unchanged on passing through the region of temperature in which the reversible polarization diminished; the broken line gives the expected deflexion of the galvanometer, if the reduction of the polarization at maximum field, shown in the hysteresis loops of the same crystal immediately afterwards, were the consequence of a real decrease of electric moment. Fig. 2 demonstrates the derivation of the polarization-temperature relation by this method at the upper Curie point. The scales of both temperature and polarization shown in the figures are still only approximate.

A fuller report will be published elsewhere, and will describe also the method for following the electric hysteresis, in which Barkhausen jumps are observed to occur some seconds and even minutes after a change of field.

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Oxidation of Olefins by Peracids

PERBENZOIC and peracetic acids are recognized reagents for the oxidation of an olefinic double bond to an ethylene oxide ring and thence to a glycol. Only a few abnormalities have been reported for this reaction[1,2,3], and so far as we are aware, none of the abnormal products have been identified.

It has now been observed that oxidation of di*iso*butylene by an acetic acid solution of peracetic acid gives an unsaturated alcohol, a glycol and higher boiling products. The relative yields of these substances depend to some extent on the experimental conditions: the amount of unsaturated alcohol formed is usually at least equal to that of the glycol, and may largely exceed it. In some preparations the unsaturated alcohol and the higher boiling material have formed the main product of the reaction.

The unsaturated alcohol has been characterized by the preparation of suitable crystalline derivatives and by hydrogenation to the corresponding saturated alcohol. The higher boiling products have yielded a viscous oil of the formula $C_{16}H_{32}O_3$, which may be considered as derived from the glycol $C_8H_{18}O_2$ by loss of the elements of water or by reaction of the ethylene oxide with the glycol. The examination of the higher boiling product is still in progress, with the object of isolating smaller amounts of other substances.

Work is now actively in progress to determine how far these abnormalities are a general feature of the reaction of olefins with peracids, and how far the experimental conditions determine the nature of the product. A detailed report will be submitted for publication elsewhere.

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Collapse of Capillaries in the Drying of Porous Gels

WHEN a rigid porous material, initially filled with liquid, dries out under falling vapour pressures, capillaries of particular dimensions will empty at particular vapour pressures. The remaining liquid is held under a hydrostatic tension which is transmitted to the walls but, as each capillary empties, the stresses on the walls due to this cause will fall to zero. If, however, the material is easily deformed, the tension of the liquid will cause a reduction in the size of the capillary, and evaporation will be delayed until a lower vapour pressure is reached, by which time the tension has further increased. This consideration is, so far as we are aware, a new one and is in addition to any shrinkage stresses which may result from the loss of vapour held by means other than capillary condensation. One may thus expect that, under certain conditions, capillaries may reach an unstable state where the tension in the liquid is increasing more rapidly than is the resistance of the capillary wall to further compression.

The simple case of a hollow circular tube subject to external and internal pressures[1] may serve to give a quantitative illustration.

A tube made of material of bulk modulus k and rigidity n has external and internal radii r_1 and r_2 ($r_2^2/r_1^2 = A$, the proportion of void space) and is subject to an internal hydrostatic tension p; the external stress being zero. Then

$$\frac{1}{r_1}\frac{dr_1}{dp} = -\frac{1}{2(1-A)}\left(\frac{A}{k}+\frac{A}{n}\right)$$
$$\frac{1}{r_2}\frac{dr_2}{dp} = -\frac{1}{2(1-A)}\left(\frac{A}{k}+\frac{1}{n}\right). \qquad (1)$$

In the case of most hygroscopic gels, k is large compared to n, so that k terms may be neglected. If the initial, unstressed values of A and r_2 are A_0 and r_0, we have by integration, when $k = \infty$

$$A_0 + \ln\left(\frac{r_0^2}{r_2^2}(1-A_0)\right) = \frac{p}{n} \qquad (2)$$

in which p is given, in terms of surface tension (τ) and contact angle (θ), by $2\tau\cos\theta/r_2$ for capillaries large compared with molecular dimensions.

To take specific examples, consider capillaries in two water-wettable materials A and B, ($\theta = 0$). In A, $n = 6 \times 10^9$ dynes per cm.^{2} (approximately that of the cell-wall material of wood at a low moisture content); and, in B, $n = 1{\cdot}5 \times 10^7$ (approximately that of soft rubber). In each of these materials n is only a few per cent of k.

Take $A_0 = 0{\cdot}5$ in each case, then with the surface tension of water in bulk at 73 dynes/cm., equation (2) is drawn in Fig. 1, which shows the *initial* radius r_0 required to produce a given *final* radius r when the tubes are dried from saturation to a relative humidity (R.H.). It shows a minimum value of r_0 at about 10^{-8} cm. and relative humidity 1 per cent for A, and at about 5×10^{-6} cm. and relative humidity 98 per cent for B. These are the smallest initial radii which can withstand drying below the corresponding minimum relative humidity without being reduced to zero cross-section by the ever-increasing tension of the water. Below the critical relative humidity no capillary water can be present and no capillary effects can be manifest since all the larger capillaries are empty and all the smaller ones have collapsed.

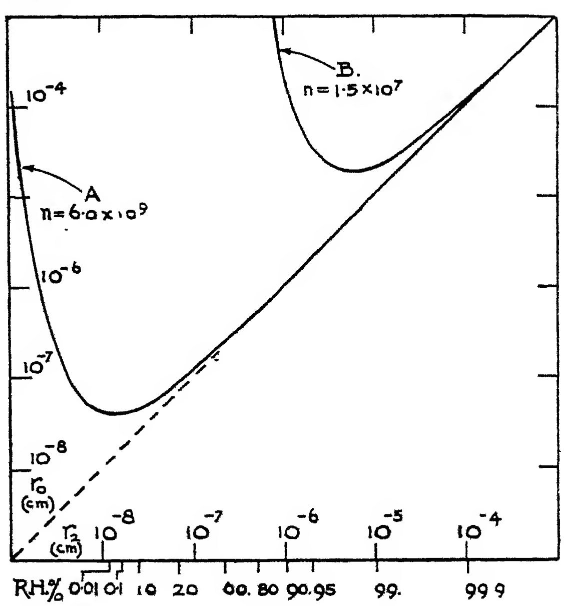

Fig. 1

These results cannot, of course, be applied quantitatively to real materials the capillary structure of which is irregular, or to such small and meaningless values of r as are obtained for curve A. Curve B has, however, a qualitative significance in showing that in materials softer than rubber, microscopically visible voids can collapse at humidities very close to saturation, causing abnormal external shrinkage at high moisture contents.

In seasoning wet wood at elevated temperatures, that is, when the rigidity is very low, anomalous shrinkage can occur in the early stages of drying. This condition is known as 'collapse', and the cell cavities are found on examination to have suffered severe distortion suggesting the flattening of evacuated rubber tubing. Previous explanations of this effect[2] have been based on the idea that water-logged cells will collapse on drying if no air is able to enter when the water evaporates. It now seems that collapse is possible even when air is not excluded.

If it be assumed that, under the very high tensions associated with the disappearance of the smaller voids, the walls remain permanently sealed together on re-wetting, one may explain how a second drying of a natural gel, such as wood, usually shows lower equilibrium moisture contents than the first, and how fine pulps (for example, paper pulp) and powders tend to adhere into larger aggregates on drying.

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Anthocyanins of *Gladiolus*

As a preliminary to genetic studies in which one of us will be concerned in collaboration with Prof. K. Hrubý, the pigments of the flower petals of *Gladiolus gandavensis* (large-flowered florist's gladioli) have been re-examined. The different varieties contain more or less of an anthoxanthin which appears to be a glycoside of apigenin or a simple derivative; this functions as a strong co-pigment. An acid aqueous extract of the yellow 'Hofmann's Glory' added to synthetic peonin or malvin makes the red solutions much bluer, and they then simulate the appropriate flower extracts. The petals do not contain a carotenoid soluble in benzene or ethyl acetate.

The system of tests has already been described[1], but it may be noted that an equivalent of the 'delphinidin reagent' is a mixture of anisole (90 c.c.), *cyclo*hexyl methyl ether (10 c.c.) and picric acid (2·4 gm.). A noteworthy feature of the results is the absence of cyanidin derivatives, although we have not been able to obtain the variety in which a cyanin type was formerly recognized. It may be noted that the streaks of colour at the base of the petals of the yellow 'Hofmann's Glory' appear to be due to anthocyanin based on cyanidin.

There are definitely three sugar types among the pelargonidin derivatives. Thus 'Crimson Glow', poppy scarlet, contains pelargonidin 3-pentoseglycoside (or rhamnoglycoside); this is probably the same pigment as that occurring in the scarlet gloxinia.

'Acca Laurentia', variegated yellow and orange, contains pelargonidin 3-bioside (two hexoses); the scarlet nasturtium is coloured by the same pigment.

'Van Tienhoven', red, and 'Rosa van Lima', delicate rose, contain pelargonidin 3 : 5-diglycoside, doubtless identical with pelargonin.

'Mrs. Marks Memary', a splendid variety with carmine flowers, is coloured by peonidin 3 : 5-diglycoside, very much blued by co-pigment.

The violet varieties examined are recent Dutch introductions and are as yet unnamed. One had deep purplish-violet flowers, like an iris or purple viola. This contained malvidin 3 : 5-diglycoside, rather strongly co-pigmented. A bluish-violet variety, less intensely coloured and much bluer, was also of malvin type but much more co-pigmented.

A variegated white and violet was also of co-pigmented malvin type. It will be of interest to see whether the sugar types of 'Acca Laurentia' and 'Crimson Glow' can be introduced by hybridization into the peonidin- and malvidin-based anthocyanins.

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Relation between Fat and (*a*) Protein, (*b*) Heat Value in Buffaloes' Milk

INVESTIGATIONS carried out by Timpe, Nils Hanson, Van Slyke and Publow[1] show that the different milk constituents bear a relation to one another. According to these authors, this relation can be expressed in a numerical equation similar to that formulated by Fleischman and Richmond correlating the density with the total solids.

The Denmark Experimental Station for Animal Nutrition investigated in 1923 this relation for cows' milk, and showed that it could be represented in a straight-line equation which was afterwards demonstrated by Langemack and Anderson to be:

Protein (%) of milk = 1·597 + 0·446 × fat (%).

It is quite evident that the figures of this equation will not apply to different species and breeds; though in different kinds of milk, protein content always increases with the increase of fat.

For buffaloes' milk, it has been established that the heat value of the milk depends upon its fat content. Much work has been done to find a formulæ exhibiting the relation between the fat content and calorific value of milk.

Møllgard studied this relation for cows' milk[2] and expressed it in the form:

Cal. per kgm. cows' milk = 115 fat (%) + 280·6.

Overman and Sadmann in the United States found a slightly different equation:

Cal. per kgm. cows' milk = 120·6 fat (%) + 267·9.

These equations are satisfactory when the amount of fat is not more than 5 per cent; if it exceeds 5 per cent, the heat value can be calculated from the following equations:

Cal. per kgm. cows' milk = 101 fat (%) + 363 (Møllgard).

Cal. per kgm. cows' milk = 100·2 fat (%) + 376·5 (Overman and Sadmann).

(Milk used in these experiments did not contain more than 7 per cent fat.)

In Egypt, buffaloes are the principal milk-producing animals. The fat content of buffaloes' milk varies from 5 to 12 per cent. This wide range of fat content makes buffaloes' milk a good material for investigating these two relations, especially since the milk investigated by Møllgard, Overman and Sadmann did not contain more than 7 per cent fat.

Milk samples were taken from a herd of buffaloes on the farm of the Faculty of Agriculture, Fouad I University, Giza. These samples were also taken from selected individuals showing maximum and minimum fat percentage. The protein and fat content of each sample were determined by the usual methods of Kjeldahl and Gerber. The calorific value was determined directly in the calorimeter after drying the milk in filter paper.

On the basis of the results obtained, it can be concluded that protein content in buffaloes' milk is directly proportional to the quantity of fat in the milk, and the relation between protein and fat can be expressed in the following equation:

Protein (%) = 3·43 + 0·1216 × fat (%).

As regards the relation between the fat percentage and heat value of buffaloes' milk, it can be concluded that heat value per kgm. milk rises in a straight line with the rise of fat percentage, and is expressed in the following equation.

Heat value (cal.) per kgm. buffaloes' milk = 110 33 fat (%) + 278 63.

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Value of Determination of Bisulphite-binding Substances of Blood in the Diagnosis of Vitamin B_1 Deficiency

DEFICIENCY of vitamin B_1 is associated with increase of the bisulphite-binding substances[1,2]. The increase is chiefly due to pyruvic acid and alpha-ketoglutaric acid. As the bisulphite-binding aldehyde- and keto-compounds increase in many different diseases, it is rather difficult to decide whether this augmentation can be used as an indicator of aneurin deficiency. The various authors disagree on this point[3]. Wilson[4] and others recommend the examination of the increase after administration of glucose. Chesler *et al.*[5] are of the opinion that the ratio of lactic and pyruvic acid is the decisive factor, the ratio being normally 7·7 average and 5·8–6·6 with aneurin-deficiency.

I therefore undertook determinations with eighty cases of the amounts of bisulphite-binding substances in the blood, at the same time determining the urinary excretion of aneurin after a test dose. If the increase of such substances was not due to imperfect oxidation or insufficient intake of carbohydrates (hunger with acetonuria, diet of fat without carbohydrates, diabetes), the bisulphite-binding substances of blood were mostly increased when aneurin-excretion was below normal, that is, if after intravenous injection of 10 mgm. aneurin less than 1·5 mgm. was excreted. Seventy-three cases showed this correspondence (91·2 per cent). In four cases the excretion of aneurin was decreased on account of deficient renal function, a fact not signifying hypovitaminosis in this case; the amount of bisulphite-binding sulphite was not increased. The highest amounts of bisulphite-binding substances were found when B_1-excretion was lowest, a circumstance explained by considerable deficiency of aneurin-intake or absorption in cases of cancer of the œsophagus, gastric stenosis, alcoholism, etc. After the administration of aneurin, the amount of bisulphite-binding substances decreased to normal values within hours or a few days, the B_1-excretion increasing simultaneously to normal level. These results seem to indicate that the aforesaid exceptions excluded, the content of bisulphite-binding substances increases mostly when there is aneurin-deficiency. The method is therefore suitable for determination of aneurin deficiency, if cases of diabetes, hunger with acetonuria, and unbalanced fatty diet are excluded. Hunger, of course, may cause concomitant aneurin deficiency. But it seems unnecessary to apply this circumstantial method, because the determination of aneurin excretion after a test dose (Magyar[6] and others) is simpler, as I[7] have ascertained by several hundred determinations conducted by its application. The method is suitable only if, on account of deficient renal, and, as I showed, of deficient liver function, the aneurin excretion is low. In these cases determination of bisulphite-binding substances decides whether the decreased excretion is due to vitamin deficiency or failure of renal- or liver-function.

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Demonstration of an Agglutinin to *Trichomonas foetus* in Vaginal Mucus

THE procedure of the demonstration of living organisms in the vaginal discharges of cattle represents the most satisfactory method at present available for the positive diagnosis of infection with *Trichomonas fœtus*. Considerable difficulties are involved, however, not the least of which arises through the capricious appearance and disappearance of the organisms from these discharges: and it was in an endeavour to find an explanation that some investigations of the properties of the discharges were made and finally led to the demonstration of trichomonas agglutinins in the mucus secretions of the vagina.

The method employed was the mixing of the mucus with melted agar, which was allowed to solidify in small Petri dishes. A suspension of live trichomonads was then pipetted on to the surface and the preparation incubated at 37° C. Agglutination was evaluated according to the scale laid down by Robertson[1] and Kerr and Robertson[2] for the assay of trichomonas agglutinins in the blood, and was actually demonstrated in the vaginal mucus of experimentally infected animals before any evidence could be found of its presence in the blood.

A series of observations that was carried out showed the disappearance of trichomonads from the discharge to coincide with the development of agglutinins in the vaginal mucus, and the subsequent reappearance of trichomonads to coincide with the disappearance of these agglutinins. It has also been noticed that the latter occurrence is usually accompanied by the appearance of a copious watery discharge which is believed to originate in the uterus[3]. The application of the test to the uterine type of discharge failed to demonstrate any agglutinins: these appeared, therefore, to be restricted to mucus from the vagina itself.

The observations seem to explain the intermittent nature of the appearance of active organisms in certain vaginal discharges; as also the well-known variability in the duration of the activity of organisms kept at room temperature in freshly collected vaginal discharges.

In addition to the demonstration of trichomonas agglutinins, it was found possible to prepare a saline extract of vaginal mucus from an animal infected with *Brucella abortus* and to show the presence of agglutinins to that organism.

This appears to be the first clear demonstration of the presence of agglutinins in vaginal mucus.

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Fluochrome in Muscle

IF crystalline myosin is made to act on adenosine triphosphate it splits off one phosphate. If the reaction is allowed to proceed to completion and the dephosphorylated product is added to actomyosin, prepared from pure actin and pure myosin, no contraction occurs. If, however, a small amount of a watery extract of muscle is added, the actomyosin contracts. The substance responsible for this reaction is an acid-stable protein. If purified and allowed to stand at alkaline reaction in air it turns yellow, displays in the ultra-violet a splendid, somewhat bluish fluorescence, and loses its activity. On addition of cysteine the colour disappears, fluorescence vanishes, and the activity returns. Evidently, the protein in question is a chromoprotein, the prostherid group of which is capable of reversible auto-oxidation, the reduced form only being active. If detached from the protein, the chromophore group becomes very labile and readily oxidizes into a non-fluorescent reddish-brown substance.

The dye is not identical with flavine or thiochrome. Its maximum of light-absorption is somewhat shifted towards the higher wavelength, as compared to flavins, and there is gradually decreasing adsorption up to 700 $\mu\mu$ with a little hump at 550.

The research was carried out at the Biochemical Institute of the University of Budapest under auspices of the Josiah Macy Jr. Foundation, New York.

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Arosa.
Aug. 5.

Effect of Vitamin P on the Thyroid in Guinea Pigs

MCCARRISSON[1] and other workers after him observed in scorbutic guinea pigs an increase in activity of the thyroid. In the course of experiments aimed at investigating the 'sparing' action of vitamin P on ascorbic acid, the thyroid was submitted to histological examination in vitamin P-deficient guinea pigs, as well as in guinea pigs fed on a normal diet supplemented with a mixture of *d*-catechin epimers, selected as a type of vitamin P.

A definite activation of the thyroid was observed in male guinea pigs weighing 250 gm. fed on scorbutigenic diet supplemented with 2 mgm. ascorbic acid a day. The histological picture corresponded to the *T*-stage of Heyl and Laqueur[2], while the control animals showed the *Q—R* stage. The result cannot be imputed to an inadequate supply of ascorbic acid, because Schulze and Linnemann[3] were able to prevent thyroid activation in guinea pigs fed on a scurvy-producing diet (presumably containing vitamin P) by a dose of ascorbic acid five times lower.

In guinea pigs, fed on a normal diet and receiving 1 mgm. *d*-catechin epimers daily, the thyroid was observed to be in the resting state on the fifteenth day: the histological picture corresponded to the *P* stage of Heyl and Laqueur[2].

It would seem that the inactivation of the thyroid is due either to a direct action of vitamin P on the gland or, more probably, to a 'sparing' effect of vitamin P on ascorbic acid.

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[1] McCarrisson, *Ind. J. Med. Res.*, **2**, 693 (1920).
[2] Heyl and Laqueur, *Arch. Int. Pharm. Ther.*, **49**, 83? (1934).
[3] Schulze and Linnemann, *Arch. Exp. Path. Pharm.*, **189**, 448 (1938).

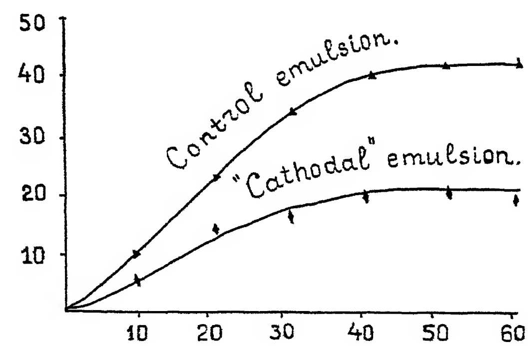
Changes in the Activity of Cholinesterase of Nervous Tissue under the Influence of Constant Current

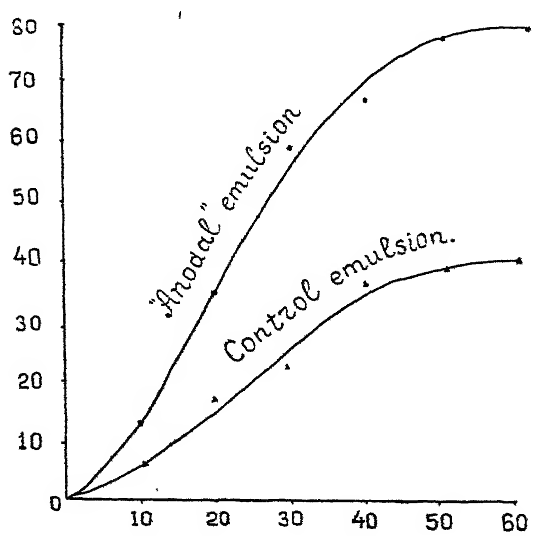
POLARIZATION of nervous tissue with constant current leads to the accumulation of acetylcholine at the cathode and to its diminution at the anode. These facts may be explained as the result of polar changes either in the synthesis of acetylcholine, or in the intensity of its enzymic breakdown. To test the validity of the second assumption, we have investigated the influence of constant current upon the activity of cholinesterase in nervous tissue. The experiments were performed with the sciatic nerve of frogs and dogs and with the cerebral cortex of dogs.

In the experiments with cerebral cortex, one unpolarizable Du Bois Reymond electrode was applied to the cortex, the second one to the cervical muscles. Polarization was continued during 5–10 min. with a current of 8–12 mA. In the experiment with nerve trunks, one electrode (either the cathode or the anode) was applied to the nerve, the second one to the muscles; the strength of the current was 6–8 m.A.

The experiments with frog nerves were performed on isolated nerve-muscle preparations with liquid unpolarizable electrodes leading to small vessels with Ringer saline. The end of the nerve was immersed 1 cm. deep in one vessel (the volume of saline was 3 c.c.), and the muscle placed entirely in the other liquid. The polarization was performed during 5–10 minutes with a current of 0·5–1·5 m.A. in one series of experiments, and of 0·01–0·3 m.A. in another series.

After the polarization, a piece of cortical tissue was taken from under the electrode. Another piece was taken at the same time from a corresponding point of the other hemisphere as a control. In the experiments with nerve trunks, two pieces were excised after the





polarization: one from the part on which the electrode had been placed, the other one from the corresponding part of the symmetrical nerve.

The emulsions obtained from these pieces of brain or nerve tissue were centrifuged; the centrifugate was placed in a water bath at 37° for one hour to destroy the acetylcholine. After this, the activity of cholinesterase was determined either by means of the gasometric method (in a Warburg apparatus) or by means of biological assay of acetylcholine not hydrolysed after a definite period (tested on the dorsal muscle of the leech and on the m. rectus abdominis of the frog). In all experiments, the action of the emulsion prepared from the polarized (cathodic and anodic) piece of tissue was compared to that of the emulsion prepared from the control piece.

More than seventy experiments were thus performed; in 90 per cent of the experiments the activity of cholinesterase was definitely affected by polarization: acetylcholine is destroyed by emulsion of nervous tissue more slowly when the tissue has been subjected to the action of the cathode than when it has been subjected to the action of the anode. This influence of polarization upon the activity of cholinesterase was equally manifested in the cerebral cortex and in the nerve fibres.

The above data are illustrated in Figs. 1 and 2. These figures demonstrate the kinetics of the enzymic hydrolysis of acetylcholine produced by cathodic, anodic and control emulsions of frog nerve, as determined by means of the gasometric method.

CHANGES IN THE ACTIVITY OF CHOLINESTERASE IN NERVOUS TISSUE
The figures denote the volume of carbon dioxide (c.mm.) liberated in 60 min. from solutions of bicarbonate due to the breakdown of acetylcholine.

No. of exp.	'Cathodic' emulsion	Control emulsion	No. of exp.	'Anodic' emulsion	Control emulsion
1	9	34	7	61	30
2	10	32	8	68·5	30
3	12	43	9	70	41·5
4	12	44	10	73	39·5
5	13	44	11	58·5	38·5
6	12·5	43	12	62·5	39·5

The fact that the cathode of constant current lowers the activity of cholinesterase, while the anode produces the opposite effect, that is, increases the activity of this enzyme, may be explained on the basis of the changes that take place in the distribution of ions in the nerve under the influence of polarization.

It is possible that the comparative increase of univalent cations in the region of the cathode lowers the activity of cholinesterase, while the comparative increase of bivalent cations in the anodal region raises it.

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Action of the Pigmentary Hormone of a Stick Insect, *Dixippus morosus*, on Vertebrate Melanophores

THE pigmentary hormone of *Dixippus*, the regulator of colour change in this animal, activates the melanophores of frogs (*Rana temporaria* and *R. esculenta*) and of the axolotl (*Ambystoma mexicanum*) by causing expansion of them. This effect can be obtained by injecting blood of *Dixippus* or Ringer's solution containing crushed tissues of *Dixippus* under the skin of these amphibians, and also by plunging fragments of frog's or axolotl's skin in Ringer's solution containing blood of *Dixippus*.

The expansion of melanophores begins after about 5–30 min. and sometimes longer, according to the species used, the individual characters of the specimen and the temperature, and lasts about twenty-four hours. Control injections and experiments show that the effect is of a specific hormonal character. The pigmentary hormone of *Dixippus* is not identical with the vertebrate melanophore hormone.

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July 17.

Electrocardiogram of the Embryo at the Beginning of the Contractile Function of the Heart and of Explants Cultivated *in vitro*

WE have resumed the experiments of Olivo and Posteli[1] on the chick embryo heart on myocardial fragments cultivated *in vitro*, with the principal purpose of ascertaining whether the normal structural microscopic evolution of the myocardius during ontogenesis is accompanied by characteristic alterations of its electrical activity, and investigating the fundamental phenomena giving rise to the electrocardiogram of the adult heart.

The material and methods selected have proved particularly convenient for the analytical investigation of these questions. The electrodes were of the unpolarizable type, silver-chloridized silver; contact was established through Ringer's solution, by means of capillary glass tubing of 10–30 μ diameter moved by a micromanipulator. The amplifier[2] has direct coupling with symmetrical negative reaction and double entry in two channels, permitting, therefore, unipolar and bipolar derivation. The sensitivity is 10 microvolt and the maximum amplification $1 \cdot 5 \times 10^6$: deviation is practically nil. Registration is by means of a cathode ray oscillograph, photographic objective sensitive paper and kymograph.

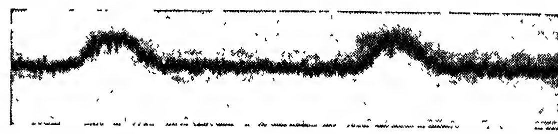

FIG. 1. ELECTROCARDIOGRAM OF A CHICK EMBRYO OF 25-H. INCUBATION, 9 SOMITES, *in vitro* FROM 40 MIN. (1 DIV. = 10^{-5} VOLT)

Young embryos. It has been shown[3] that the heart in the chick embryo begins to pulsate normally during the differentiation of the ninth pair of somites. Until the stage of 10–11 somites, the myocardius is free from myofibrillæ. Later on myocardial fibrillæ appear, first smooth then striated and in gradually increasing quantities.

The electrocardiograms of 26 embryos in the stages of 9–18 somites were recorded. In two embryos of 9 and one of 10 somites, we have obtained records consisting of a simple, slow, nearly sinusoidal half-wave. One perceives the absence of quick waves (Fig. 1). Thus we have so improved on the limit of 15 somites attained by Hoff, Kramer and others[4]. In two embryos at the stage of 7 and 8 somites respectively, the hearts of which had not begun to beat, it was possible to take a first record about an hour after the heart had begun to pulsate *in vitro*.

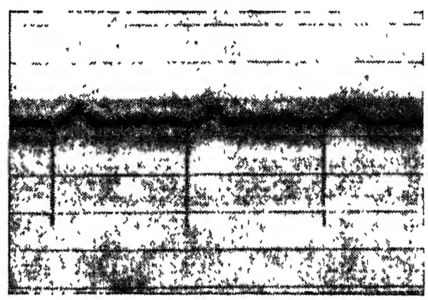

FIG. 2. ELECTROCARDIOGRAM OF AN ATRIAL FRAGMENT OF A CHICK EMBRYO OF 15-DAYS INCUBATION, *in vitro* FROM 12 DAYS (1 DIV. = 2×10^{-5} VOLT)

Quick impulses and myocardial fibrillæ. The whole embryos or the isolated cardiac primordia survive well *in vitro* and their histological differentiation progresses[5]. Taking the electrocardiogram of cardiac primordia at different stages of development, or repeatedly on the same primordium at an interval of 6–36 h., we have found that at the stage of 11–12 somites, with the appearance of the first myofibrillæ, one begins to perceive a very small quick wave which precedes the slow one. At 14–15 somites the quick wave is already stronger marked, until one obtains successively a complete electrocardiogram like that of the normal adult heart with the quick group QRS and the slow wave T (Fig. 2).

The explants cultivated *in vitro* for many days show increasing undifferentiation until the myofibrillæ totally disappear[6]. In those conditions their electrical records go back to the characters shown by the youngest primordia.

Electric potential of one fibre. We have recorded the electric potential of isolated fibres, spontaneously dissociated during cultivation *in vitro*. Such fibres are generally histologically undifferentiated. Their electric waves are slow, and quick impulses are absent.

Conduction velocity. Recording the electric potential of two points of the preparation, each in respect of the liquid in which it is immersed (unipolar derivation), and then the potential deriving from the difference of the two tensions (bipolar derivation), and as a check that obtained with the two electrodes inserted parallel, we have shown that there is a phase difference between the quick impulses at the two points. This phase difference is of the order of a hundredth of a second at distances between the two points of the order of one tenth of a millimetre.

Potentials recorded. In the very early stages (9–10 somites) the maximum potential is of the order of $50–100 \times 10^{-6}$ volt; but in all other cases, for whole embryos, myocardial fragments, and also single fibrillæ, the maximum potential recorded is of the order of $0 \cdot 5–1 \cdot 5 \times 10^{-3}$ volt.

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July 31.

[1] Olivo, O. M., and Posteli, T., *Mem. R. Accad. Sci. dell'Istituto di Bologna*, ix, 10 (1942–43).
[2] Petralia, S., and Ricamo, R., *Nuovo Cimento*, ix, 3 (1946).
[3] Olivo, O. M., *Arch. Exper. Zellf.*, 1, 427 (1925).
[4] Hoff, Kramer, du Bois, Patten, *Amer. Heart J.*, 17, 470 (1939).
[5] Olivo, O. M., *Verh. Anat. Ges.*, 37; *Anat. Anz.*, 66, 108 (1928). *C.R. Assoc. Anat.* (1928).
[6] Olivo, O. M., *Arch. Exper. Zellf.*, 8, 250 (1929).

Source of Oxygen Liberated during Photosynthesis

PROF. HUGH NICOL's note, "Photosynthesis, Philosophy and Priestley", in *Nature* of August 10, p. 200, mentions G. Bredig (1914) as the first to suggest that the photosynthetic oxygen comes from water. It may be of interest to know that J. Liebig (*Ann. Chem. Pharm.*, **46**, 58; 1843) gave the following picture of the carbon dioxide assimilation of plants:

$$2CO_2 + H_2 = \begin{matrix} COOH \\ | \\ COOH \end{matrix},$$

involving the formation of hydrogen and oxygen from water. More recently, I considered (*Camera-Luzern*, **4**, No. 6; 1925) a reaction in line with Willstätter's assimilatory coefficient $CO_2/O_2 = 1$ and with von Bayer's (1870) formaldehyde theory, and I formulated the following scheme:

$$H_2CO_3 + 2H + 2OH = HC\overset{O}{\underset{H}{\lessgtr}} + H_2O_2 + H_2O_2 \text{ and}$$

$$2H_2O_2 + \text{catalase} = 2H_2O + O_2.$$

Both the reducing hydrogen and the hydroxyl radicals were supposed to be photolytic products of water. According to these formulæ three-quarters of the oxygen liberated comes from water; one molecule being involved in the reaction

$$CO_2 + H_2O = H_2CO_3$$

and two mols in

$$2H_2O + \text{activated chlorophyll} = 2H \text{ (active)} + 2OH.$$

K. Shibata and Yakushi (*Naturwiss.*, **21**, 267; 1933) give a similar representation. Four mols of water are involved to give first

$$4H_2O = 4H + 4OH, \text{ and then } 4H + CO_2 = HCOOH + H_2O.$$

Finally,

$$4OH = 2H_2O_2 \text{ and } 2H_2O_2 + \text{catalase} = 2H_2O + O_2.$$

According to this concept, all the liberated oxygen comes from water and none from carbon dioxide.

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A New Genus of Cucurbitaceæ

AN interesting plant was discovered in Assam in 1883 by the late Gustav Mann. Later, Mr. I. H. Burkill found it in Abor Hill during his expedition in 1911 and 1912 (Burkill, No. 37363 and 37742). After a lapse of twenty-two years, Dr. N. L. Bor again found the plant in April 1933 at a place called Painjuli, Aka Hills. Mann's sheets were examined at Kew by the late C. B. Clarke, who thought this to be a new species of *Zanonia*.

In 1939, while trying to name a few of Dr. Bor's Aka Hill collection at the Calcutta Herbarium, I came across this plant. Soon Mann's and Burkill's sheets were found and an examination was made of the floral parts. From the data obtained it was not possible to fit this new plant within *Zanonia* as suspected by Clarke. It proved to be a new genus under the tribe *Fevilleæ* of Cogniaux and is closely allied to *Thladiantha* Bunge. The description was drawn up and sent to Kew in 1940, but owing to the War the publication was delayed for a few years. The main characters of this genus are given below for the benefit of other workers in different parts of the world.

Indofevillea Chatterjee Gen. nov. Affinis *Thladiantha* Bunge sed sepalis petala longe superantibus squamis floribus nullis, antheris liberis subsessilibus, reniformibus hirsutis, pistillodio nullo fructuque multo majore satis discrepat. Species unica Assamica (*Indofevillea khasiana*).

A full account will appear in *Kew Bulletin*.

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Aug. 19.

Size of Sampling Unit in Yield Surveys

IN a previous communication[1] I directed attention to the risk of obtaining biased estimates of crop yields with sampling units of small size. Further results confirming these findings are now available. Of particular interest are the results of the investigations on paddy (rice) in the Gaya district in Bihar and the Kistna district in Madras. The Gaya district has a geographical area of 4,766 sq. miles, of which approximately 35 per cent is under paddy. It is divided into four sub-divisions. The plan of sampling consisted in selecting at random 108 villages, 36 from the Gaya division and 24 from each of the other sub-divisions. In each selected village two paddy-growing fields were selected at random, and in each selected field the following five sampling units were marked: (*a*) one rectangle of size 33 ft. × 16½ ft., area 544·5 sq. ft.; (*b*) two equilateral triangles of side 15 links, area 42·4 sq. ft.; and (*c*) two isosceles right-angled triangles with the equal sides equal to 5 ft. area 12·5 sq. ft.

The sampling units (*a*) and (*b*) were marked with the help of pegs and tapes, but the sampling unit of 12·5 sq. ft. was marked with the apparatus devised and used by Mahalanobis in the Bihar rabi survey (1943–44)[2]. The experiments were carried out by the Circle officers posted in the district, each working within his own jurisdiction. Altogether seventeen officers were employed.

The results are presented in Table 1. It will be seen that the sampling unit of 12·5 sq. ft. results in a serious over-estimation of yield, the percentage over-estimation being 23. Even a sampling unit of 42·4 sq.

TABLE 1. THE GAYA DISTRICT

Sampling unit	Area in sq. ft.	No. of sampling units harvested	Estimate of the average yield in lb. per acre	Percentage over-estimation
Rectangle, 33 ft. × 16½ ft.	544·5	206	991·54	
Equilateral triangle, side 15 links	42·4	412	1078·77	8·7
Right-angled isosceles triangle with equal sides 5 ft. each	12·5	412	1221·12	23·1

ft. gives an over-estimate of nearly 9 per cent. An examination of the yield estimates for each sub-division showed that small-size sampling units gave biased yield estimates in all divisions.

A proper test of bias is to compare yield estimates from sampling units of different size with those obtained from harvesting the whole field. This was not found feasible in the investigation carried out in the Gaye district. Another investigation was, therefore, carried out on paddy in the Kistna district of the Madras Province. The results are shown in Table 2. It will be seen that the yield estimate from sampling unit of 435·6 sq. ft. is in close agreement with that obtained from harvesting the whole field, but those from small-size sampling units

TABLE 2. THE KISTNA DISTRICT

Sampling unit	Area in sq. ft.	No. of sampling units harvested	Estimate of the average yield in lb. per acre	Percentage over-estimation
Whole field		108	1939·2	
Rectangular plot, 50 links × 20 links	435·60	108	1954 1	0·8
Circle of radius, 3 ft.	28·29	216	2025·9	4·5
Circle of radius, 2 ft.	12·57	216	2113·2	9·0
Equilateral triangle of side 5 ft.	11·12	216	2433·4	25·5

are over-estimates. The differences are all found to be statistically significant. An examination of the results for each sub-division also showed a close agreement between the yield estimates from sampling units of 435·6 sq. ft. and those obtained by harvesting the whole field; but the yield estimates from small-size sampling units were considerably different from the latter. The bias observed was positive (over-estimate) in certain sub-divisions and negative (under-estimate) in others, but did not cancel out when the results were combined for the district, as one might expect when experiments are carried out by several investigators.

These results confirm the conclusions of the previous investigation on wheat, that sampling units of 12·5 sq. ft. used by Mahalanobis in India[2] and of the size used by workers in Britain and the United States result in biased yield estimates under Indian conditions.

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Aug. 3.

[1] Sukhatme, P. V., *Nature*, **157**, 630 (1946).
[2] Mahalanobis, P. C., *Sankhya*, **7**, 29 (1945).

John Ray's Tomb

RECENTLY, when making a tour of some of the Essex churches, I visited Black Notley, and was concerned to find that the monument to John Ray in the churchyard had been seriously damaged by a bomb which fell nearby, so the Rector informs me, on December 10, 1943. The monument has been figured by Gunther ("Further Correspondence of John Ray", 1928), and earlier by Lankester ("Memorials of John Ray", 1846). It consists of a rectangular base surmounted by a pyramid with a decorative plinth and finial. The base is protected by an iron railing. The latter is only slightly affected, but the base of the monument itself was broken and blown open so as to be exposed to the weather. The finial was also snapped off.

It is unthinkable that the tomb of so famous a naturalist should be allowed to remain in such a state, and we may hope that the public bodies more directly concerned, the Royal and Ray Societies and the Essex Field Club, will take the initiative in the task of restoration. Ray was born and died at Black Notley, and spent the last twenty-six years of his life there. His home in the village, which he built in 1655, was destroyed by fire in 1900, and hence the monument is all that is left to remind us of his association with the place. I may add that the Rector of the parish, the Rev. J. L. Head, is anxious to co-operate in any scheme for the repair of the tomb.

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Aug. 15.

INDUSTRIAL SPECTROSCOPY

THE recently formed Industrial Spectroscopic Group of the Institute of Physics held its first conference at the Wellcome Research Institution, London, during July 5 and 6. Mr. F. Twyman, chairman of the Group, presided at the conference, which was attended by representatives from Belgium, France and Holland in addition to a large number of British members. Under the general heading "Recent Developments in Industrial Emission and Absorption Spectroscopy", the five principal contributions dealt with modern equipment and techniques for both emission spectrography and infra-red absorption spectroscopy; a full report of the papers will appear in due course in the *Journal of Scientific Instruments*. Lack of time prevented any detailed consideration of ultra-violet absorption spectroscopy; this subject, however, has received very recent attention at another general discussion on spectroscopic analysis (see *Nature*, June 29, p. 883).

Mr. Twyman, opening the conference, welcomed the visitors from abroad, and stressed the importance of providing a common meeting ground for those interested in emission spectroscopy and absorption spectroscopy in application to industry. He reminded the audience that both these aspects of the subject were envisaged by Kirchhoff and Bunsen in 1860.

Dr. H. W. Thompson, after discussing the underlying principles of infra-red absorption spectra, gave a number of examples of the principles used in applying these spectra to recent problems of qualitative and quantitative analysis. For example, current methods for the analysis of cresylic acid are not very satisfactory. However, the infra-red spectra of *ortho*-, *meta*-, and *para*-cresols show marked differences in the region 11–14μ, and this has recently been used to analyse mixtures of the three isomers. The sensitivity and accuracy are both high, since the key bands used for the estimation have high intrinsic extinction coefficients. Commercial mixtures of xylenols and related substances can be examined in the same way. Another problem which has recently been worked out satisfactorily is the rapid analysis of mixtures of acetic acid and acetic anhydride, the former having a key band at 1,288 cm.$^{-1}$ and the latter one at 1,125 cm.$^{-1}$. Much work has recently been carried out on the analysis of mixtures of hydrocarbons and fuel samples. The particular value of the method when examining fractions from distillation columns is that the infra-red spectrum characterizes the components beyond doubt, whereas methods based on such properties as refractive index or density may lead to serious error.

G. F. Lothian, in a paper on the equipment for absorption spectrophotometry in the infra-red, reminded the audience of the position some twenty years ago, when it was often necessary to spend a whole night plotting perhaps one spectrum. During the nineteen-thirties, automatic recording became fairly general and the time required for plotting a spectrum was reduced to something less than thirty minutes; the most recent apparatus now records a similar spectrum range in about a minute. The principal features which have contributed to this enormous improvement in speed and convenience are: (*a*) larger prisms of synthetic material; (*b*) greatly improved radiation receivers (thermopiles, bolometers, etc.); (*c*) improved amplifying circuits; and (*d*) improved spectrometer design. It is now possible to obtain synthetic crystals of lithium fluoride, sodium chloride, potassium bromide and potassium iodide for prism materials, and descriptions of American instruments of the last ten years are noteworthy for the large sizes of prism mentioned, for example, 10 cm. $\times$ 15 cm. Modern thermopile and bolometer designs show increases in both speed and sensitivity. For example, recently quoted time constants of American bolometers are so low as 0·01 sec., while thermopiles of the sensitive Schwarz type may have time constants so low as 0·02 sec. Mr. Lothian also described modern absorption cells of adjustable length, detector circuits and recording devices, and gave descriptions of several instruments commercially available in Great Britain and in America, including the Hilger recording infra-red spectrometer, which operates on the double-beam principle; this makes a direct record of the corrected spectral transmission of the sample. All these are prism instruments using Littrow or Wadsworth mounting with mirrors for collimation. Among the most novel infra-red spectrometer recorders is one recently described by Daly and Sutherland (see *Nature*, April 27, p. 547), which uses a cathode ray tube with long persistence screen to give a visible record. This uses a high-speed bolometer, the A.C. output from which is fed direct to a valve amplifier and thence to the plates of a cathode ray tube.

An alternative to dispersing the radiation into a spectrum is to use selective filters to isolate the spectral region required for absorption measurements. Pfund and, more recently, N. Wright, have described an ingenious arrangement giving a selective receiver. The receiver consists of a pure specimen of the material to be analysed or else another substance with an absorption band in the same region. If continuous radiation is passed through such a receiver it absorbs selectively and is heated by the required wave-length band. The heating may be measured by an ordinary bolometer wire. As one example, Wright has used this arrangement to estimate ethyl benzene by measurement of its ethyl group absorption band at 3·4μ. The receiver consists of a film of ethyl cellulose in contact with a bolometer wire. The time of response is only 20 sec. The German Luft apparatus for gas analysis is based on the same principle. More than four hundred of these instruments were in use in Germany in 1944, principally for carbon dioxide analysis using the 4·25μ band.

Dr. Thompson continued the discussion of apparatus by mentioning the availability of a small wattage globar (silicon carbide) infra-red source with platinized ends. This source has advantages over the Nernst filament, particularly at wave-lengths beyond 20μ. He also mentioned thallium bromo-iodide as an optical material; this is stable to water and most solvents, and exhibits some transmission out to 70μ. This opened up the possibility of examining thin aqueous films of proteins between plates of this material. After some discussion of non-metallic bolometers ('thermistors') and their advantages, Dr. Thompson concluded by describing a new cathode ray tube type spectrometer in which the spectrum appears as a line trace on the screen. This may have particular application to the study of infra-red emission spectra (see *Nature*, Aug. 10, p. 197).

In the ensuing discussion, Dr. W. C. Price pointed out that double-beam spectrometers, although having very attractive features, require considerable skilled maintenance on the electrical side; also the standard of perfection required for the slit mechanism is very

high. The demands on optical perfection in the case of double-beam spectrophotometers used in the visible region are much less exacting, since the background absorption is then much less variable; their use in this range is becoming standard practice. In America, infra-red spectrometers of the single-beam type that can be evacuated or completely desiccated are now favoured. Dr. Price asked that instrument makers in Great Britain should design infra-red spectrometers so that they can either be desiccated or hermetically sealed.

J. Savage mentioned a number of points in connexion with German practice, including the use of an alloy of composition 65 per cent iron, 30 per cent chromium and 5 per cent aluminium as an infra-red source material in place of the Nernst filament. This material has been found very satisfactory, requiring no initial heating and having a long life. It was also mentioned that analytical methods based on the Raman effect were in use in Germany; these had the advantage of low initial cost.

Dr. A. C. Menzies said that it is important to bear in mind the severe limitations as well as the great advantages of the Raman effect. First, the intensity of the Raman lines is such that the material of interest must be present in a concentration exceeding about 10 per cent for the method to be of value. Also the material must not be affected by the incident light, nor must it absorb the exciting line. On the other hand, one plate can include lines corresponding to infra-red wave-lengths from some hundred microns down to a few microns; also one can get, at present, better resolution.

The second day of the conference was devoted to emission spectroscopy. Messrs. A. S. Nickelson and F. W. J. Garton described the various types of equipment now in use for the quantitative analysis of metals and inorganic substances. The use of the emission technique for the qualitative and semi-quantitative analysis of such materials is of long standing, but recent improvements in the apparatus available have improved the accuracy of the method sufficiently to enable it to be used with confidence for determinations normally carried out by chemical means. Among other matters the paper dealt with the various types of spectrograph available and discussed the respective advantages of prism and grating forms. Apparatus for the identification and measurement of spectral lines was also reviewed. Finally, consideration was given to the various methods now being evolved to eliminate photography of the spectrum, including some of the photo-electric techniques now in use in the United States.

Dr. A. C. Menzies described a new attachment by means of which 35 mm. film can be used on the standard form of Hilger spectrograph designed for use with 10 in. × 4 in. plates. The film is contained in a circular box at one side of the attachment and fed across, as desired, to a removable cassette at the other side, pressure on the film being relieved during the movement. A cut-off knife is included in the attachment, and either a single length or several exposure lengths in series may be removed as desired.

E. C. Knowles emphasized the real need for a low-priced spectrograph which would come within the purchasing-power of technical colleges. This would enable the fundamentals of spectrochemical analysis to be taught effectively. At present very few students can enter industry with any practical knowledge of this branch of analysis.

A. Walsh gave a review of the various light sources and associated circuits for the spectrographic analysis of metals and alloys. For accurate analysis, it is essential that the vaporization and excitation of the material under test proceeds in a controlled and reproducible manner. Two main types of source have been used in the past: the direct current arc for analyses where sensitivity is required, and the condensed spark for accuracy. The need for sensitivity combined with accuracy, and for even higher accuracy than that obtained with a simple condensed spark, has resulted in the development of new circuits which represent a considerable advance in analytical technique. Mr. Walsh described the new 'general purpose source unit' which he has developed in the laboratories of the British Non-Ferrous Metals Research Association. Although the processes which occur are not yet completely understood, certain general conclusions can now be drawn as to what characteristics are to be expected from a given type of discharge. One interesting recent finding is the fact that the method of 'triggering' the discharge affects the subsequent discharge to a marked extent. Another important point is that in many circuits increased reproducibility of electrical conditions does not indicate an increased reproducibility of light-emitting characteristics. In fact, the very opposite may occur. Thus the selection of a suitable type of discharge is at least as important as the meticulous control of the electrical process.

Dr. R. Taylor and D. C. Shotton described some tests that had been carried out at the Post Office Research Station in connexion with circuit characteristics. The lay-out of the apparatus always introduces additional components of resistance, capacitance and inductance, while resonance between the condenser and the leakage inductance of the transformer often falsifies the quoted transformer voltage. Oscillograms of the condenser voltage applied to the analysis gap demonstrated that the number of sparks in each half cycle increases with the applied voltage. When very large numbers of sparks are produced, transient direct-current arcs may also occur. Stabilization of the breakdown voltage of the gap, obtained, for example, by use of an air blast combined with carefully controlled electrical conditions, will be necessary before similar results can be obtained in different laboratories.

Prof. R. Breckpot described work carried out in his laboratory at the University of Louvain; this had remained unpublished because of the War. In establishing optimum working conditions for the uninterrupted direct-current arc, it was important to study not only the influence of current, voltage and arc length, but also the conditions governing the actual energy distribution from anode to cathode, the absorption by stationary vapour, and even the age of the arc. The time effect may be caused by differences in volatility, but also by chemical reaction. For example, the relative intensities of calcium to barium, or strontium to barium, when arcing mixtures of the chlorides change markedly as a result of the conversion to oxides—the spectral intensities being correlated with the heats of formation and ionization potentials.

D. M. Smith gave a number of examples to illustrate the point that the most persistent lines of elements vary not only with the source of excitation impurity (as would be expected) but also with different materials, using the same source of excitation.

H. T. Shirley gave the final main contribution to the conference, "A Statistical Examination of Sources of Error in the Spectrographic Analyses of Low Alloy Steel". Most of this work was carried out with a single sample of nickel-chromium-molybdenum steel. This sample was used to prepare thirty-one plates, from each of which thirty spectrograms were read, involving some 60,000 readings from upwards of 9,000 separate lines. These readings were so taken as to permit statistical examination for the separation of the variability into three portions, corresponding essentially to: (*a*) excitation response; (*b*) plate variability over small distances comparable with the length of line read; (*c*) micro-photometry errors. For five elements considered, the mean figure for total variability, expressed as percentage of the element content, varied from 1·7 to 2·5, according to the electrode arrangement and the type of plate used. The sparking response variability made the greatest contribution to the total variability, whereas the small-scale plate variability contributed the least.

The final discussion concerned the mechanism by which research could be sponsored to improve further the analytical applications of spectroscopy. The chairman felt that such research lay largely in the province of the universities, but Dr. C. L. Wilson emphasized that if industry wanted results it should pay for them. He felt that a promising method of operation might lie in fellowships of the type now coming to the fore. In addition, however, to the foundation of such fellowships, which will supply men with the time for continued application to abstruse problems, there must be some provision made for the coincidental supply of the very expensive apparatus needed for spectrography and other physical methods of analysis. B. S. COOPER

DETERIORATION ON STORAGE OF DRIED SKIM MILK

By KATHLEEN M. HENRY and S. K. KON
National Institute for Research in Dairying, University of Reading

C. H. LEA
Low Temperature Station for Research in Biochemistry and Biophysics, Cambridge

J. A. B. SMITH and J. C. D. WHITE
Hannah Dairy Research Institute, Kirkhill, Ayr

HENRY and Kon[1,2] found, by the method of Mitchell[3,4], that the biological value of the proteins of a bulk of dried skim milk stored at room temperature under conditions which did not exclude atmospheric moisture gradually deteriorated from 88·5 when the powder was a year and a half old to 71·1 three years later. At the end of the storage period the powder contained 7 per cent moisture. Findlay *et al.*[5] had already observed that for samples of full-cream milk powder stored at 37° C. and 47° C., there was a critical moisture content below which fat deteriorated first and above which severe non-fatty deterioration was the first to occur. The latter type of deterioration resulted in unpleasant gluey flavours, marked darkening of the powder, and a great decrease in the solubility of the protein. It was immediately realized that the two observations were probably closely related. A large-scale experiment was therefore planned by the three research institutes concerned, with the object of making a thorough investigation of the changes which occur during storage of skim milk powders.

With the helpful co-operation of the Scottish Milk Powder Company, two samples of spray-dried skim milk were prepared within a short time from very similar bulks of milk, to contain respectively 2·9 and 4·7 per cent moisture. Half of the sample containing 4·7 per cent moisture was allowed to absorb moisture from the atmosphere until the content rose to 7·3 per cent (as measured by drying for 3 hours at 100° C. under atmospheric pressure; after drying to constant weight under 30 mm. pressure at 100° C. the figures for the three powders were 3·0, 5·0 and 7·6 per cent respectively. The three powders were stored in small gas-tight cans in air or nitrogen at 37° C., 28·5° C. and 20° C. At intervals during storage the atmosphere in the cans was analysed and the powder examined for colour, solubility, moisture content and, when reconstituted, for flavour and *p*H. Changes occurring in the free amino-nitrogen of the protein and in the various nitrogenous constituents of the powder were investigated, and the amount of sugar combining with the protein was estimated. The biological value of the proteins in a number of the samples was determined by the methods of Osborne *et al.*[6] and of Mitchell[3,4], and true digestibility was measured. Microbiological assays of all essential amino-acids are also being carried out in order to determine whether the deteriorated protein is deficient in any of these acids: the results will be reported later.

Before the main experiment was started, it was thought that the deterioration of the milk proteins previously observed[1,2] might have been due to oxidative changes, and that cystine was the amino-acid most likely to be affected by them. This view was strengthened by the opinion of Fairbanks and Mitchell[7] that the initial decline, on heating, in the biological value of dried milk was due to a partial destruction of cystine. Tests showed, however, that,

CHANGES IN DRIED SKIM MILK OF 7·3 PER CENT MOISTURE CONTENT AFTER STORAGE IN NITROGEN FOR 60 DAYS AT 37° C.

		Fresh powder	Stored powder
Carbon dioxide produced (mgm./100 gm. powder)		—	5·8
Apparent moisture content of the powder, %		7·3	6·7
Equilibrium relative humidity, %		42	55
Colour of the powder, Lovibond yellow plus red units		0·5	2·2
Solubility at 20° C., %		99	70
Flavour of the reconstituted milk		Palatable	Nauseating, caramelized gluey
Casein N	Amount present in the soluble portion of the powder, expressed as % of the total nitrogen in the fresh powder	80·7	6·8
Albumin N		2·3	none
Globulin N		3·7	4·6
Proteose and Peptone N		6·8	12·8
Non-protein N		6·5	6·7
*p*H of the reconstituted milk		6·73	6·50
Reducing power[8], moles × 10^{-5} ferricyanide reduced/gm. milk solids		0·9	16·0
Free amino-N content of the protein, as % initial value		100	36
Reducing sugar combined with protein, as mgm. lactose/gm. milk solids		6	49
Biological value*, method of Osborne *et al.*[6] (gm. gain/gm. protein consumed) without added lysine		2·81†	1·82
(gm. gain/gm. protein consumed) **with added lysine		2·59†	2·55
Method of Mitchell[3,4] without added lysine		84·5	67·5
,, ,, **with ,, ,,		76·4	80·1
True digestibility, without added lysine		91·2	86·0
,, ,, **with ,, ,,		91·4	89·0

* Determined at an 8 per cent level of protein intake (N × 6·38) derived from 23 per cent milk in the diet.

† The values quoted here were obtained with a control sample which had been kept in nitrogen at −20° C.

** Lysine added to the milk at a rate of 2·5 per cent.

while the addition of cystine improved the biological value of the proteins of freshly dried milk from 90·4 to 95·2, it was without effect on a deteriorated powder, the change from 76·6 to 77·9 being without statistical significance. Moreover, freeze-dried milk benefited from the addition of cystine, the biological value of the proteins increasing from 90·1 to 97·3. It thus became evident that, although the biological value of the proteins of milk was from the outset limited by their cystine content, cystine was not primarily involved in the deterioration caused by the storage of dried milk.

The results of the storage experiments, of which those given in the accompanying table are typical, showed that the powder of highest moisture content, particularly at the higher storage temperatures, deteriorated rapidly, with loss of palatability, solubility and biological value of the protein. Chemical changes included a slow decrease in pH of the reconstituted milk, a progressive fall in the free amino-nitrogen content of the protein, and a corresponding appearance of reducing sugar in considerable quantity combined with the protein of the milk. Other changes observed were absorption of oxygen (by the samples packed in air) and evolution of carbon dioxide, crystallization of the lactose (as shown by changes in apparent moisture content and in equilibrium relative humidity of the powder), and a progressive increase in the reducing power of the powder towards ferricyanide (Chapman and McFarlane method[8]). Dialysed milk protein freeze-dried and stored at 37° C. and 55 per cent relative humidity for relatively long periods showed no appreciable loss of free amino-nitrogen, which, however, fell rapidly when reducing sugar was re-introduced prior to storage.

It seems probable that these changes arise, in part at least, as the result of a Maillard reaction between the aldehyde group of reducing sugar and free amino-groups of the protein, which will consist largely of the ε amino-groups of lysine residues, together with such terminal α amino-groups of other amino-acids as are exposed at the end of peptide chains. Certainly lysine becomes less available to rats as deterioration proceeds, and the lost biological value can be largely restored by supplementing the deteriorated powder with lysine (the addition of lysine to the control powder caused a statistically significant decrease in the biological value of its proteins; this finding, which may be compared with the observations of Murlin *et al.*[9], is now under investigation). Microbiological assay of lysine after hydrolysis with acid or with pancreatin disclosed a small or a considerable loss of this amino-acid respectively; although even after enzymic hydrolysis the loss of assayable lysine was still smaller than that indicated by Van Slyke amino-group determination on the unhydrolysed protein.

Similar changes occurred in the powder with 4·7 per cent moisture, but at a much slower rate. In the powder with 2·9 per cent moisture deterioration was relatively very slight even after a year at 37° C. The temperature coefficient for deterioration was unusually high, with the result that at high storage temperatures the rate of deterioration of powder of high moisture content was very rapid indeed. An atmosphere of nitrogen instead of air slightly retarded protein deterioration, but failed to prevent it.

Protein deterioration on storage has previously been observed by chemical or biological methods in wheat and wheat flour[10], in soya-beans[11,12], in maize[11,13] and in egg white[14]. Destruction of lysine by heat has been observed in milk[15], casein[16] and oat protein[17]. With casein and oat protein, some of the lysine was rendered unavailable to enzymic digestion, although it could still be released by acid[17,18].

The experiments are still in progress, and will be described in detail later. It is important, however, that the very deleterious effect of high moisture content on the nutritive value of dried milk should be known, so that this type of deterioration may be avoided in future by manufacturing only powder of low moisture content and by storing the powder in moisture-proof containers, conditions which can readily be fulfilled.

We are indebted to Dr. R. A. Kekwick, Lister Institute of Preventive Medicine, for the preparation of the freeze-dried milk.

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VITAMIN B AND FAT ANABOLISM

THE ability of the higher animals to synthesize fat from both carbohydrate and protein sources, first shown by Lawes and Gilbert in 1852 in connexion with the fattening of pigs, has been fully confirmed by modern researches on rats. It is now clear that the various B vitamins are intimately concerned in these processes of fat synthesis. Recent developments in this field are largely due to E. W. McHenry of Toronto, and have been reviewed by E. W. McHenry and M. L. Cornett (*Studies from the Connaught Laboratories and School of Hygiene, University of Toronto*, **16**; Univ. of Toronto Press, 1945).

Concerning the synthesis of fat from carbohydrate, it was shown that the amount of body fat laid down by rats on a high-carbohydrate fat-free diet was dependent on the B vitamins present in the diet. In the absence of thiamin no fat at all was laid down; when thiamin was added, considerable fat deposition occurred and the respiratory quotient rose well above unity. With thiamin present, the amount of fat laid down could be further increased by the addition of riboflavin, pyridoxin, pantothenic acid or biotin to the diet, but in the absence of thiamin the other B components had no effect. It seems that thiamin is essential for the synthesis of fat from carbohydrate and that other components of the B complex can augment the synthesis.

The fat laid down under the influence of thiamin differed considerably from the 'normal' body fat of the animal; it contained a higher proportion of C_{16} acids and a lower proportion of unsaturated acids. When other B components were fed in addition to thiamin, the quality of the deposited fat was further changed. The relative proportion of C_{16}, C_{18} and unsaturated acids depended on the relative proportion of the various B components in the diet. In particular, biotin increased the formation of unsaturated acids. So not only do the vitamin B components increase the quantity of synthesized fat but also, severally, they determine the quality of the fat.

In these experiments deposition of cholesterol always paralleled the deposition of neutral fat. It is generally recognized, however, that changes in cholesterol always accompany changes in neutral fat, however produced, and there was no reason to suppose that the B vitamins had any specific effect on cholesterol synthesis.

The question arises, can this function of thiamin in fat synthesis be linked in any way with its more generally known function in carbohydrate metabolism? It is known that thiamin is necessary for the enzymic removal of the pyruvic acid which results from carbohydrate catabolism, for pyruvate accumulates in the blood of thiamin-deficient animals. The chemical pathway from carbohydrate to fat is still not certainly known, but considerable evidence points to acetaldehyde as the intermediate compound. It is possible, therefore, that one way in which thiamin removes pyruvate is by converting it to acetaldehyde, the acetaldehyde being then synthesized to fat. Another observation which can be correlated here is the 'thiamin-sparing' action of fat. On a high-fat diet, less thiamin is required for normal maintenance. The explanation of this may be that under these conditions there is no call for fat synthesis, so no thiamin is consumed in this process and more is available for other functions.

Concerning the synthesis of fat from protein, it was shown that in rats on a diet high in protein and free from carbohydrate, fat and vitamin B, body fat was only laid down when thiamin and pyridoxin were added to the diet. It was also shown that thiamin and pyridoxin were essential for the formation of glycogen from protein, but other evidence suggested that the synthesis of fat from protein does not proceed via carbohydrate. It is also known that pyridoxin-deficiency develops more rapidly on a high-protein diet, and it seems likely that pyridoxin is concerned in some way with protein degradation.

This new knowledge of the importance of B vitamins in fat synthesis raises a point in connexion with the so-called 'essential' fatty acids. It is well known that when certain unsaturated fatty acids (linoleic and linolenic) are absent from the diet, rats show loss of weight and also skin lesions, and it was concluded from these experiments that these fatty acids were essential to the animal economy and that the animal body had no power to synthesize them. In these experiments, yeast was used to provide the B vitamins, and re-examination of the experimental data shows that the supply of some of the B components, notably biotin and pyridoxin, may have been suboptimal. The possibility that, given an optimal supply of all the B vitamins, the animal can in fact synthesize these unsaturated fatty acids, requires further investigation.

PURIFICATION AND ADSORPTION OF DIPHTHERIA TOXOID

By HANS ERICSSON
Bacteriological Laboratory, Stockholm

THE method for purification of diphtheria toxoid, which has been used at the State Bacteriological Laboratory of Sweden since 1943, consists of two different procedures: the so-called iso-electric precipitation with trichloracetic acid of the crude toxoid and the aluminium precipitation of the partially purified material. The method, described briefly in an earlier publication[1], is founded on investigations by Boivin and Yzard[2] and by Glenny and Barr[3].

Boivin and Yzard described a method for purification of different toxins and toxoids, including diphtheria toxoid, by precipitation of the toxoid with trichloracetic acid and resolution of the precipitate in sodium phosphate solution. In a second publication[4], Ramon, Boivin and Richou found that the solution of the purified toxoid had the same biological activity as the crude toxoid.

Glenny and Barr[3] found that the immunizing power of diphtheria toxoid was enhanced by addition of alum, and that it was possible to purify the toxoid by separating the precipitate formed and redissolving it in Rochelle salt solution. They did not discuss further the nature of the process and the composition of the precipitate.

By an appropriate combination of the methods of Boivin and Yzard and of Glenny and Barr, I found it possible to obtain a rather high degree of purification and a firm adsorption of the active substance to the precipitate. For practical purposes the purification and adsorption procedure has been used for toxoid prepared on broth according to Philippe and Loiseau only; but it should be applicable on other toxoids as well, and the method may give still better results if, for example, semi-synthetic mediums are used for the toxin production.

The initial material consists of Ramon's toxoid prepared from the cultures in broth according to Philippe and Loiseau. It contains up to 40 Lf. and about 5 mgm. of total nitrogen per c.c., corresponding to 8 Lf. per mgm. of nitrogen. The pH of the crude toxoid is lowered to 3·0–3·5 by addition of an appropriate amount of a 50 per cent solution of trichloracetic acid, which precipitates the active substance. The precipitates are collected by centrifugation, redissolved in a 3 per cent solution of sodium dihydrogen phosphate, giving a pH of 8·4, and finally tested for toxoid content by the flocculation method of Ramon. Care should be taken that the iso-electric precipitation is carried out at a temperature of 18° C. The yield is about 90 per cent of the original amount of toxoid.

The second stage of the process consists in the precipitation by aluminium salt. Aluminium chloride is added as a sterile solution containing 96 gm. per litre, 1 litre being added to 9 litres of purified toxoid. By this addition the pH of the solution is lowered to about 4·5 and a precipitate of aluminium phosphate is formed. The precipitate is left to settle over-night. On the following day the supernatant fluid is syphoned off as completely as possible, and a physiological solution of sodium chloride substituted for it. The pH is adjusted to 5·8. Before the flocculation, the

precipitate is dissolved by addition of a few grains of sodium citrate.

The iso-electric precipitation forms the main part of the purification procedure, giving a purification of about twenty times. The aluminium precipitation is mainly intended to give a precipitate of aluminium phosphate, enhancing the immunizing power of the toxoid.

The end product contains about 50 Lf. per c.c., 0·2 mgm. of nitrogen and 1·0 mgm. aluminium per c.c. The concentrations of the different solutions are chosen so as to give finally a buffered physiological solution of sodium chloride of pH 5·8.

The immunizing power of the toxoid has been tested by inoculation of guinea pigs at the Swedish laboratory and also by Glenny at the Wellcome Research Laboratories and has been found to fulfil the British requirements for diphtheria toxoid.

A toxoid manufactured in this way has been used for public immunizations of children in Sweden, about two million injections having been carried out during 1944–45. The primary results as judged by the conversion-rate of the Schick reaction are excellent, one single injection of 50 Lf. changing the reaction from positive to negative in 98 per cent of the cases. The duration of the negative Schick reaction has not yet been sufficiently controlled, but would not be expected to be very long after a single injection. Epidemiological evidence tends to show that the general immunizations against diphtheria in Sweden during the War have been effective.

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CARNEGIE CORPORATION OF NEW YORK

ANNUAL REPORT

THE annual report of the Carnegie Corporation of New York for 1945 includes the reports of the president, the secretary and the treasurer for the year ended September 30, 1945. Grants voted amounted to 1,002,500 dollars for undertakings connected with the war effort and for projects of long-term interest to the Corporation. The total of 567,000 dollars during the year for undertakings connected with the national emergency raises the total of such grants during the past five years to 2,711,867 dollars. Grants to established national research agencies for studies of education and economics include 75,000 dollars to the Carnegie Foundation for the Advancement of Teaching, for the development of its graduate record examination project; 75,000 dollars to the American Council on Education for a study of the implications for civilian education of educational experience in the armed forces; 25,000 dollars to the National Bureau of Economic Research and 5,000 dollars to the National Academy of Sciences for preliminary work in connexion with the establishment of a research board for national security. Agencies concerned with research and general education in foreign affairs received grants amounting to 257,000 dollars, including 100,000 dollars to the Carnegie Endowment for International Peace, 50,000 dollars to the Institute of International Education, 42,000 dollars to the Institute of Pacific Relations and 45,000 dollars to the Council on Foreign Relations.

In his inaugural report, the new president, Mr. D. C. Josephs, reviews the purposes of the Corporation, the general standards to be maintained in making grants and the dangers likely to arise in giving money to institutions and individuals. The Carnegie Corporation is an American foundation, most of the resources of which have been dedicated to the service of the American people, and accordingly the Corporation should not hesitate to provide funds for those who can show better ways to democracy, to the freedoms of thought, race, religion and enterprise. Projects selected for support must, however, be not only of public interest, but also, because the Corporation's income is limited, they must have great possibility of public benefit. Pointing out that knowledge is advanced by new ideas which may not yet be sufficiently developed to fit into a formal list, Mr. Josephs declines to list the kinds of projects or define precisely the fields which the Corporation should cultivate, but indicates some of the requirements which should be met before an enterprise may be supported. In particular, he points out that its support should be reserved for enterprises that deal with causes rather than effects. Once the project has proved itself or become useful, it should be supported by less venturesome money and the Corporation will withdraw support. Money is given to a man or an institution who has an idea and has the force and skill to advance it towards a conclusion.

Discussing next the dangers in giving, Mr. Josephs notes that premature endorsement may destroy good ideas that have not yet been sufficiently developed. If a large amount of money is ploughed into any field, a crop of results of some sort is fairly sure to follow; but it is possible to raise a crop which has a bad effect on neighbouring fields, and by overstimulating the development of certain subjects research may be made to run far ahead of ability to integrate. Integration may also be attempted before enough research has been done. Another danger is that of offering generous grants too widely to individuals in academic life. A year or two of stimulating investigation with the assistance of a grant may tempt an effective teacher to desert the field in which he has been successful, or he may become loath to return to the classroom. Mediocrity and dispersion are two particular dangers in handling philanthropic funds because they are insidious.

Mr. Josephs notes that it has been a long-established policy in the Corporation not to contribute to social service organisations established to relieve need or misfortune. In view of the endowments of the Carnegie Institution of Washington, it is not probable that many grants of the Carnegie Corporation will be made to develop biological and physical sciences, nor is it expected that much, if any, of the income of the Corporation will go in future to permanent endowments or for bricks and mortar. It is the purpose of the Carnegie Corporation to share in creative enterprises, and Mr. Josephs hopes that the Corporation will be able to consider proposals from those who were prepared to devote their energies to proving or disproving the reality of their vision in the field of formal or informal education, whether in the traditional or in a wider sense.

FORTHCOMING EVENTS

Tuesday, September 10—Wednesday, September 11

INSTITUTE OF METALS (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Autumn Meeting.

Tuesday, September 10

At 2.30 p.m.

Wednesday, September 11

At 10 a.m.

Wednesday, September 11

ROYAL INSTITUTE OF CHEMISTRY (in the Small Assembly Hall, Town Hall, Luton), at 6.30 p.m.—Dr. A. M. Ward: "Science as a Career".

BRITISH ASSOCIATION OF CHEMISTS (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Mr. J. S. Evans: "The Factory Acts as they Affect Chemists".

Friday, September 13

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

Friday, September 13—Sunday, September 15

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at the Fyvie Hall, The Polytechnic, 309 Regent Street, London, W.1).—Twenty-first ASLIB Conference.

Friday, September 13

At 4 p.m.—Tea and Conversazione; at 6 p.m.—Annual General Meeting.

Saturday, September 14

At 10.30 a.m.—Sir Reginald Stradling, F.R.S.: "Special Libraries in Research Organisations" (Presidential Address).

Sunday, September 15

At 10.30 a.m.—Symposium on "Some Aspects of Documentation in Europe To-day" (Speakers: Mr. Lancaster-Jones, Miss Esther Simpson and Mr. Ronald Fraser).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH ASSISTANTS, WORKSHOP TECHNICIANS and DRAUGHTSMEN, in the Department of Physics—The Registrar, The University, Liverpool (September 14).

LECTURER IN CHEMISTRY, and a LECTURER IN PHYSICS AND MATHEMATICS—The Clerk, Northern Polytechnic, Holloway, London, N.7 (September 14).

LECTURER (Grade II) for Fisheries work at the Port Erin Station, and a RESEARCH ASSISTANT (with knowledge of some branch of Biology and of Mathematics)—The Registrar, The University, Liverpool (September 15).

LECTURER IN THE DEPARTMENT OF ANATOMY—The Registrar, University College of South Wales, Cathays Park, Cardiff (September 16).

ASSISTANT LECTURER IN ZOOLOGY—The Secretary, King's College, Strand, London, W.C.2 (September 16).

LECTURER IN GEOGRAPHY—The Secretary and Registrar, The University, Bristol (September 20).

LECTURER with special responsibility in PRODUCTION ENGINEERING in the Coventry Technical College—The Director of Education, Education Offices, Coventry (September 21).

ASSISTANT PHYSICIST for duties in the X-Ray and Radium Department of the North of England Joint Cancer Organisation—The Town Clerk, Town Hall, Newcastle-upon-Tyne (September 21).

RESEARCH ASSISTANT IN PLANT PHYSIOLOGY, and an ORGANIC CHEMIST, at the Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (September 21).

JUNIOR BIOCHEMIST at the Teaching and Research Laboratory in the Maudsley Hospital Post-Graduate Medical School, Denmark Hill, Camberwell, London, S.E.5—The Medical Officer of Health (B), Mental Health Services, County Hall, Westminster Bridge, London, S.E.1 (September 22).

LECTURER IN PHYSICS—The Principal, Derby Technical College, Normanton Road, Derby (September 23).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (September 27).

RESEARCH CHEMIST, and a RESEARCH PHYSICIST, in the Department of Glass Technology—The Registrar, The University, Sheffield (September 28).

LECTURER AND FIELD WORK SUPERVISOR, and a SENIOR DEMONSTRATOR (Group Work Supervisor), in the Department of Social Studies, The University, Melbourne—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (September 30).

MUSEUM ASSISTANT (man or woman) in the DEPARTMENT OF GEOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (September 30).

CHAIR OF MINING—The Secretary, The University, Edmund Street, Birmingham 3 (October 1).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER, Division of Industrial Chemistry, Melbourne, to engage in the development of a Section of Ceramics Research—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 957 (October 4).

SENIOR ASSISTANT IN MATHEMATICS, a SENIOR ASSISTANT IN PHYSICS, and a SENIOR ASSISTANT IN CHEMISTRY—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (October 11).

LECTURER IN MICROBIOLOGY in the Department of Bacteriology—The Registrar, The University, Sheffield (October 21).

DIRECTOR OF THE WEST AFRICAN INSTITUTE OF TSETSE FLY AND TRYPANOSOMIASIS RESEARCH—The Director of Recruitment, Colonial Office, Victoria Chambers, 15 Victoria Street, London, S.W.1 (October 30).

CHAIR OF ELECTRICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 3 (November 1).

LECTURER IN THE DEPARTMENT OF PATHOLOGY in the Medical School, Dundee—The Secretary, The University, St. Andrews (November 16).

ECONOMIC BOTANIST for service in the Research Division, Department of Agriculture and Forests, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1 endorsed 'Economic Botanist, 168'.

LECTURER IN THE DEPARTMENT OF METALLURGY AND CHEMISTRY, College of Technology—The Director of Education, Education Offices, Rotherham.

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LECTURER IN METALLURGY at the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough.

LECTURER IN PHYSICS, a LECTURER IN MATHEMATICS, and a LECTURER IN CHEMISTRY—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

LECTURERS IN THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN BOTANY—The Principal, Heriot-Watt College, Edinburgh.

LECTURER IN MECHANICAL ENGINEERING—The Principal, Heanor Mining and Technical School, Ilkeston Road, Heanor, Nottingham.

LECTURER IN METALLURGY—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

LECTURER IN MATHEMATICS—The Acting Principal, Technical College, Huddersfield.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

B.A.N.Z. Antarctic Research Expedition, 1929–1931. Reports, Series A. Vol. 4 (Meteorology and Terrestrial Magnetism), Part 1: Terrestrial Magnetism. By Dr. Clinton Coleridge Farr. Pp. 32. 3*s*. 6*d*. Reports, Series B (Zoology and Botany). Vol. 4, Part 7: Endoprocta. By Dr. T. Harvey Johnston and L. Madeline Angel. Pp. 213–232. 3*s*. 6*d*. Vol. 4, Part 8: Nemerteans of Kerguelen and the Southern Ocean. By Dr. J. F. G. Wheeler. Pp. 233–256. 3*s*. 6*d*. Vol. 4, Part 9: Decapod Crustacea. By Herbert M. Hale. Pp. 257–286. 5*s*. Vol. 5, Part 1: Pycnogonida. By Dr. Isabella Gordon. Pp. 72. 10*s*. Vol. 5, Part 2: Parasitic Nematodes. By Dr. T. Harvey Johnston and Patricia M. Mawson. Pp. 73–160. 12*s*. 6*d*. (Adelaide: Barr Smith Library, The University, 1940–1945.) [53

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SCIENTIFIC INFORMATION SERVICES

WITHIN the limits of its survey, the report of the Royal Society on the needs of research in fundamental science after the War indicates that there is little the matter with the existing structure of research in Great Britain : with increased endowment, the provision of new research institutes in such fields as oceanography, microbiology, meteorology, geophysics, ecology, and with an adequate supply of scientific workers, it should be capable of expansion, without substantial modification, to meet the increased needs of to-day. There is, however, one important direction in which the findings of the report are closely parallel with those of the report which, under the title "Science—the Endless Frontier", Dr. Vannevar Bush presented last year to the President of the United States. One of the specific questions on which Dr. Bush was asked for recommendations was what could be done to make known to the world, as soon as possible, the contributions to scientific knowledge which had been made during the war effort. Dr. Bush's review of the structure of research in the United States gives emphasis to this question of the full and free interchange of publication and its value as a stimulus to scientific research, and it is clearly recognized by him, as by the committee under Dr. Irwin Stewart which reported to Dr. Bush on this subject, that this is a matter requiring international collaboration as well as national action.

It is not surprising, therefore, to find that the Royal Society's report makes some important comments on the question of publication grants. During the War, publication of results of scientific investigations required financial assistance to the extent of £5,000–£6,000 per annum over and above that provided by the scientific societies from their own resources. This sum was provided partly out of the "parliamentary grant in aid of scientific publication" administered by the Royal Society, and partly out of special war-time gifts put at the disposal of the Society for the purpose by the Rockefeller Foundation and the American Physiological Society. The amount of published matter has been between one half and one third of that before the War, but it is estimated in the report that in physics and chemistry alone at least two thousand separate papers will now be released for publication but cannot be published without substantial assistance from Treasury funds. Unless these papers are published, much of the advance of science during the War will not be recorded, and, apart from British science not receiving its credit for what has been accomplished, science will lack the stimulating effect of these advances in knowledge.

Nor is this all. Some reprinting will be required to replace scientific publications and the contents of libraries lost through enemy action, and abstracting and documentation services are already a constant drain on the resources of societies that undertake such work. The Royal Society, in this report, does not overlook the possibility of some economy being achieved by collaboration between the various scien-

tific publishing agencies, though past experience does not encourage much hope as to achieving large economies by this means. The estimate that the Treasury grant for scientific publications allocated by the Royal Society should be increased from £2,500 a year before the War to about four times that sum for several years after the War appears to be reasonable.

The necessity of Government support in this matter, however, strengthens the argument for a further and full examination of the whole technique and practice of the publication of scientific papers. From the point of view of scientific information services the subject was indeed discussed at some length at the Empire Scientific Conference, which had before it a series of papers on the dissemination of scientific information. These included contributions from Sir David Chadwick, Sir David Rivett, who also discussed abstracting and library services, Dr. B. F. J. Schonland, Mr. D. Cairns of New Zealand, Dr. B. J. A. Bard and Messrs. C. T. Bray and C. E. Howling, as well as a paper on the dissemination of scientific information to the general public prepared by a working party under the chairmanship of Sir Richard Gregory. The latter paper suggested the formation of an Institute of Scientific Information which would include among its functions the maintenance, in a readily available form, and kept up to date as a daily routine, of a record of all scientific research in Great Britain, in the Commonwealth and in the world as a whole, together with the names of the men of science involved.

Whether in fact such an elaborate scheme is practicable—and the recommendations of the Conference itself, under the heading "Scientific Information Services", do not refer to this proposal—there is a clear need for something extending the scope of the "Official Yearbook of the Scientific and Learned Societies of Great Britain and Ireland", the "Yearbook of the Universities of the Empire" and Colonel L. Newcombe's "The University and College Libraries of Great Britain and the Empire", all of which are now very much out of date. The labour entailed in the compilation by the staff of the Information Bureau available to the delegates to the Conference of a list of researches indicates the value of one further means of locating scientific staff and centres of research; but the recording of research results as distinct from projects is rather a matter for indexing and abstracting, as discussed by Dr. S. C. Bradford in his paper on "Complete Documentation".

Dr. Schonland, in his paper, suggested that some five steps should be taken. One of these, the publication of scientists' guides for technical and scientific officers visiting any part of the world, would be met in part by the proposal just indicated. Linked with this is the creation of pools of information, to which research officers of the Commonwealth would contribute. Two other proposals deal with special information techniques—the creation of a Commonwealth microfilm organisation and an examination of the possibility of developing the circulation of scientific films illustrating new scientific developments for industry, education and research.

Dr. Schonland's first and major proposal is an examination of what new services of information and technical news digests are required, and this suggestion is implicit in the general recommendation from the Conference to invite the Royal Society, at an early date, to convene a conference of the libraries, societies and institutions responsible for abstracting and information services, in order to examine the possibility of improvement in existing methods of collection, indexing and distribution of scientific literature, and for the extension of existing services. Particular regard would be paid by such a conference to the cost of such services and to the need for funds from Government sources for their support. Moreover, in line with the earlier recommendation of the British Commonwealth Science Committee's report in this field, it is proposed that observers from the United States should be included with representatives of the appropriate authorities in the Dominions, India and the Colonies.

This conference is intended to consider especially the interests of scientific men as users of scientific information, and it is suggested that consideration should be given to the abstracting of Dominion journals locally for transmission to the main abstracting bodies in the United Kingdom. This proposal may or may not fit in with Dr. Bradford's suggestion that the comprehensive cover required in abstracting the current scientific and technical literature will best be secured by arranging for the scrutiny of all current literature by existing abstracting agencies on the basis of the Universal Decimal Classification, a view which Sir Clifford Paterson discussed in a memorandum on "Science Abstract". On an economic appraisal the conference might well find that some existing agencies are redundant. Moreover, consideration of the publication, classification and distribution of papers in separate form or as reprints may well lead to the discussion of more fundamental reform of publication practice in accordance with the ideas put forward by Prof. J. D. Bernal and others.

Some of the delegates to the Empire Scientific Conference showed themselves more awake to the need for rationalization in this field and for reconsidering the whole question of handling scientific publications in the light of the new techniques, such as microfilm, and the increased speed of communication. Air mail, for example, should now make it possible to consider the publication of a single abstracts journal for each of the main sciences for the English-speaking nations, whether within or without the Commonwealth. Mr. Cairns of New Zealand, while suggesting that a reduction in the number of scientific periodicals should be attempted, and urging the encouragement of microfilm and photostat for the transmission of information between countries, thought also that an efficient central abstracting system in each Empire country should be inaugurated. A similar idea, when ventilated at an ASLIB Conference in 1944, found little encouragement, and the proposal could scarcely be justified economically, as an elementary comparison of the circulation of, say, *Chemical Abstracts* and *British Chemical Abstracts* shows.

The soundest line of advance appears to be on the basis of divisions of science rather than on geographical distribution, and it will be noted that Dr. Schonland, too, has indicated the keen interest of the South African Council for Scientific and Industrial Research in the development of new methods of scientific publication and their organisation, and referred particularly to the building up of scientific libraries in microfilm. Mr. Cairns had also in mind the expansion and centralization of abstracting and reviewing facilities in connexion with industrial research, though his suggestion that organisations comparable with the Imperial Agricultural Bureaux should be set up in this field is open to question. It might even be argued that the abstracting work of these Bureaux could be more effectively organised as part of a centralized system by sciences.

If the Conference has served to make men of science and administrators more open-minded on this question it will have done good, for the discarding of prejudice and a willingness to find the most effective means of serving the needs demonstrated are a first condition of progress, whether within the orbit of a Commonwealth conference or of one under the ægis of the United Nations Educational, Scientific and Cultural Organisation, which is equally interested. Abstracting and indexing, however, form only one part of the problem of information services, and the Empire Scientific Conference already recognized that it was important not merely to improve the mechanism and system of publication but also the means by which published material—and unpublished information—was transmitted throughout the world. This, however, is not solely a matter of adequate machinery. Much depends also upon the librarian, the information officer and others engaged in such work, and the importance attached to this factor by the Conference is shown by its recognition that the qualifications of staff in scientific information services and special libraries call for special training and selection. The provision of facilities for increasing the number of properly trained staff was recommended by the Conference, and must receive attention if the network of information services throughout the Dominions is to function efficiently when established. More may indeed depend on the personality, energy and vision of the information officer than on the actual machinery which he administers.

There can be no question as to the complexity of some of the administrative problems involved even when agreement has been reached as to the organisation to be established. As Sir David Chadwick points out in his paper, for administrative reasons, centres of information conceived on the plan of the Imperial Bureaux cannot be multiplied indefinitely to meet the particular needs of every possible group, however small. The applications of science to the needs of man may be conveniently regarded for departmental purposes as agricultural, medical and industrial, but those terms have no meaning as regards the natural sciences themselves. Science as such cannot be departmentalized, and Prof. Farrington Daniels, of the Metallurgical Laboratory, University of Chicago, has commented on the handicap to the research programme in the Manhattan Nuclear Research Project caused by the compartmentalization of scientists on the Project, which prevented the free exchange of scientific reports and information from one laboratory to another. That, in passing, illustrates the relevance of this question of information services to the efficient use of scientific man-power. Sir David Chadwick further urged that centres of scientific information could serve adequately the needs they were primarily intended to serve only if they worked together and joined in common effort on the borderlands where both had something to contribute either to meet the needs of their own groups or of other special groups.

There was little reference in the papers presented to the Conference, however, apart from that of Mr. Cairns, to the urgent need to down-grade the security classification of much of the information forwarded to Empire countries during the War. The Royal Society's report gives an indication of how acute the problem of publication may become in consequence of the release of such papers. Moreover, there are other difficulties here, some of which are touched upon by Prof. Daniels in his paper "Plans and Problems in Nuclear Research" at the meeting of the American Physical Society at Chicago on June 21, 1946 (*Science*, **104**, 91; 1946). The situation in regard to nuclear research is unique rather in degree than in kind. In other fields also men of science have worked feverishly for four years or more without the opportunity of publishing their material either in book form or in periodicals. Much of it exists in reports which will never be published, though most of them require co-ordinating and re-writing in the light of subsequent findings.

While, however, much of the nuclear research material to which Dr. Daniels specifically refers is now declassifiable and provision has been made for revision of the rules for declassification of the secret documents of the atomic energy project from time to time, publication is still a difficult problem as between book form and scientific periodicals. Scientific periodicals may be reluctant to accept material once published in book form, and if much has just been published in scientific periodicals it may be difficult to find a publisher. Review articles constitute another problem, as there is risk of the reviewer, in making up articles from unpublished project reports, skimming off the cream for publication from the scientist's own paper.

The difficulty is most acute in the field of nuclear research, and we may have here an opportunity of trying out sectionally the practicability of such ideas as those of Prof. Bernal and Dr. Pirie. Whether or not a solution of this particular problem is to be found along these lines, it is by concentrating on the fundamental questions and principles that we can best hope to secure agreement and the establishment of the machinery required to serve those needs. There is much thinking to be done on such problems before the conference contemplated by the Empire Scientific Conference can lead to fruitful results, and that thinking should be the concern of every scientific worker who realizes the extent to which free com-

munication and efficient information services can help him in his work. The development of bibliographical services, both nationally, within the British Commonwealth, and internationally, as well as of British information services overseas, are questions of high importance for ensuring that full and rapid exchange of information upon which scientific advance and the most efficient use of scientific manpower depend. Bibliographic and information services, the free and effective publication of scientific and technical papers are a pre-condition for the most efficient results to be secured from the interchange of staff and the increased mobility which was also recommended by the Empire Scientific Conference. While the encouragement and development in this way of the most fruitful conditions for scientific work is a responsibility which more and more devolves on the Government that very tendency makes it more imperative that scientific workers should re-examine the agencies and institutions for the communication of knowledge, whether by abstracts, original papers or in other ways, to ensure that they are appropriate to the purpose, that there is no avoidable redundancy or overlapping, and that any public subsidy to their activities will be wisely and economically administered.

PHILOSOPHY OF ATOMIC PHYSICS

Philosophic Foundations of Quantum Mechanics
By Prof. Hans Reichenbach. Pp. x+182. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1944.) 3 dollars.

In the preface of this work, the author tells us that he "has tried to develop a philosophical interpretation of quantum physics which is free from metaphysics"; a somewhat puzzling sentence, since much of his treatment might properly be described as metaphysical, in the traditional meaning of the word. No doubt what is meant is that the book is concerned only with the epistemological side of metaphysics, and leaves ontology out of account; an attitude which will be widely approved, in a book designed primarily for the edification of physicists.

The discussion soon arrives at the problem which was so baffling twenty years ago, and which is still not entirely cleared up in the minds of many people: How can a pulse of light, or an electron, be conceived both as a wave and as a particle? Indeed, we may say that the whole volume is devoted to the study, in its widest aspects, of the difficulty that is indicated by this question.

The world of physics may be divided into (1) *phenomena*, namely, observations, or statements which may be inferred from observations in a direct and simple way, and (2) *interphenomena*, namely, the unobservable events which happen between the phenomena. For example, the adventures of light between its emission and its impact on matter belong to the class of interphenomena; so does the process by which an electron in an atom is transferred from one orbit to another when the atom makes a transition between two stationary states.

A theory of physics cannot well avoid giving some account of what is happening in the interphenomena; and herein is the source of our difficulties: for it is possible to frame alternative hypotheses about interphenomena, so that there is a certain arbitrariness of description attached to them; thus in atomic physics we have as alternatives the wave and the particle descriptions. Any description, however, which (like the wave and particle descriptions) represents interphenomena exhaustively, that is, in such a way that the values of unobserved entities are completely defined, cannot avoid anomalies, that is, occasions when the postulates of causality are not satisfied. The causal anomalies in the case of the wave description do not occur at places corresponding to those where they occur in the particle description, and they can therefore be transformed away by using, on every occasion, the description appropriate to the occasion; thus we sometimes regard light as constituted of waves and sometimes as constituted of particles. The contradictions between the wave and particle descriptions of the same phenomenon can never be brought to the test of experiment, because they lie within the domain governed by Heisenberg's principle of uncertainty. Thus it is impossible in the nature of things to say definitely that one of these conceptions is more true or more false than the other; and it is impossible in the nature of things that either of them, or any other 'exhaustive' description, can represent all interphenomena without leading to causal anomalies.

The fundamental problem is therefore not so much that of the structure of the physical world, as of the *language* in which that structure is to be described. Can a language be invented which will avoid statements expressing causal anomalies? As we have seen, such a language cannot belong to the 'exhaustive' class.

Prof. Reichenbach offers a solution of this problem, by proposing a new language different from both the wave language and the particle language. He starts from the consideration that propositions in quantum mechanics are of three kinds: (1) those which are verifiable; (2) those the contradictories of which are verifiable; and (3) those which are not verifiable and the contradictories of which are not verifiable. In some domains of quantum mechanics, the whole problem consists in determining to which of these three categories any particular statement belongs. For example, the proposition "The value of a quantum-mechanical entity before a measurement is the same as the value found by the measurement" belongs to the third category; and this is the all-important fact which solves the difficulties raised by Einstein, Podolsky and Rosen in their well-known paper in the *Physical Review* of 1935.

In order to deal with this situation, the old antithesis between 'true' and 'false' propositions is inadequate, and we are compelled to discard the Aristotelian 'Principle of the Excluded Middle', namely, that of two contradictory judgments, one must be true and the other false. This decisive step opens the way for the construction of a new non-Aristotelian logic, a "three-valued logic" as it is called. Such a logic is already in existence, and indeed has been used by Brouwer as the basis of his 'intuitionist' philosophy of pure mathematics. The three categories mentioned above are usually called 'true', 'false' and 'indeterminate', though evidently the words are not used in quite the same sense as in ordinary two-valued logic. The three-valued logic supplies the new language appropriate for quantum mechanics.

Ordinary symbolic logic, as developed in Whitehead and Russell's "Principia Mathematica", represents two-valued logic; but the three-valued logic also can be put into symbolic form by introducing additional symbols. For example, there are now three different symbols representing negation: if we denote the value 'truth' by T, 'indeterminate' by I, and 'false' by F, then 'cyclical negation', denoted by $\sim A$, turns T into I, I into F, and F into T; 'diametral negation', denoted by $-A$, turns T into F, I into I, and F into T; and 'complete negation', denoted by $\bar{A}$, turns T into I, I into T, and F into T.

When the three-valued logic is used to describe quantum-mechanical occurrences, it becomes possible to make statements about interphenomena and to connect them with statements about phenomena, and to manipulate all propositions by strictly logical symbolic operators; but statements expressing causal anomalies are eliminated from the domain of true statements. The causal anomalies are not *removed*, because they are inherent in the nature of the physical world, but they are not *asserted*.

The language of three-valued logic makes it possible to state Bohr's Principle of Complementarity in a symbolic form. Two statements A and B are said to be *complementary* when they satisfy the relation "If A is true or false, B is indeterminate": in the symbols introduced above,

$$A \vee \sim A \rightarrow \sim\sim B,$$

where $\vee$ stands for 'or'. Evidently if A is complementary to B, B is complementary to A. If u and v are two quantum-mechanical entities the operators of which do not commute, then the statement 'u has the value u'' and the statement 'v has the value v'' are complementary in this sense.

We may congratulate the author on an interesting and valuable book. EDMUND T. WHITTAKER

REFLEXIONS ON PLANNING: A PLEA FOR THE FAMILY

The State of Public Knowledge

By K. E. Barlow. Pp. 112. (London: Faber and Faber, Ltd., 1946.) 8*s*. 6*d*. net.

WHATEVER defects this book may be held to possess, no one will suggest that Dr. Barlow lacks courage. Defying traditional philosophy, and in a spirit partaking of the holoism of Smuts, he develops further on an epistemological basis the argument he outlined in "The Discipline of Peace" for a re-consideration of man's relations with the living world of Nature and an attempt to redress the evils which have arisen from man's interference with the balance of Nature. He has now given us a dissertation on the limits of public knowledge which sets the lights at amber on the road to planning, and challenges outright the gospel of State control and nationalization as it is often preached to-day. In some ways in this new approach he is more fundamental as well as less doctrinaire than Hayek or Polanyi, and the chapter "Physics and Politics" which contains the core of the book is a brilliant little essay. With a trifle more in the same vein, Dr. Barlow might have given us a classic to set on the shelf beside Bagehot, but unfortunately his earlier chapters are heavy reading. The style is laboured, and lacking the felicity of expression which marks the final chapters; these chapters may well deter some readers from reaching the valuable and original observations which make this little volume a true tract for the times.

Examining first the processes of knowledge, Dr. Barlow describes in some detail the physiological instruments of the sense of sight to illustrate how the integrative power of reason works. Physiological and psychological experience lead him to the view that conclusions to be drawn from the experience our senses give us can never amount to the sum total of the business of knowing. As in his earlier book, his insistence on what he calls the indwelling pattern of life, "the biological order which is the nursery of that potency and fertility of life, which moving through its proper order, is alone capable of giving quality and richness to the associations of men", lead him to stress the need, not merely for preserving the wholeness of life, but also the creative synthesis of personalities which resides in the family. In the integration of the family he sees the only hope. In the family we have the cradle in which human life is nurtured; families, and families only, he urges, are the cells out of which life forms the tissues of human society, and in a world where the overwhelming bias of materialism is so destructive of family life, the first business of society is to pay due regard to the provision of conditions which favour the integration of the powers which are latent within the family.

Here Dr. Barlow shows himself, like Mr. Lewis Mumford, a true disciple of Patrick Geddes, and his argument enforces Mumford's contention that good planning will rest on the solid foundations of the family and the region, emphasizing the biological and social needs of the people and treating industrial and financial needs as subordinate. Further, he holds that the social situation of modern man is already so extreme and the momentum of social change so great, that no approach from the side of government and compulsion can redeem it. The creative forces to which contemporary society must return to build anew an association which will release the creative powers of life and bring the indwelling potency of men into ordered balance with the greater disciplines of Nature, are at present repressed and latent within the fundamental unit of society, the family.

This is Dr. Barlow's central thesis, and it is to such problems that public knowledge should now be urgently directed. As in his earlier book, he seeks to correct the excessive focusing of public knowledge upon the physical side of life while we lack frames of reference adequate for the comprehension of life, its individual organisation, its units in human society and its ecological successions. Knowledge, he reminds us, cannot play the part of the processes of life, and even those who find his physiological or epistemological argument difficult to follow can scarcely fail to be impressed by his illustrations in his chapter on "Physics and Society" of the limitations of physical methods in the study of biology, the gaps in our knowledge of biological order, and the distortions of society due to the impact of physical science in the absence of such knowledge.

To read this chapter against the background of current events is to realize how far we are yet from studying the needs of men with the same dispassionate interest which we display in our examination of the units of matter and energy. Our elaborate scientific culture has done nothing to answer some of the most

significant questions in our experience, or even to formulate them: we have not as yet even the beginnings of an adequate public knowledge to guide this phase of our social action. On the location of industry and the question of education, Dr. Barlow reminds us that the nature of human need is, in the scientific sense, unknown and that industrial organisation grew up under the urge of new physical knowledge without giving heed to social organisation, human need or biological order, and not in the endeavour to satisfy the needs of men. He challenges the whole idea of vocational education and pleads passionately for education for life, and for a culture which will display to its generation the true responsibility of men within an order of life which imposes its own natural law.

For this chapter alone the book deserves to be read. Implicit in it is a plea for fundamental thought, for a re-orientation of education, for sociological research that goes right to the heart of our problems of industrial organisation, whether from the angle of nationalization or of relations between workers and management, of production and of employment. Without attention to those values and principles of biological order to which Dr. Barlow directs attention and some real attempt to erect a system of public knowledge which will serve as a framework by which we may refer to the order of life revealed to our experience by the intruding universe, full employment and social security will prove delusions. The quality and vitality of Dr. Barlow's thought are unmistakable, and when his freshness of outlook and originality are uppermost there is no lack of lucidity. There are passages in his book which develop further ideas given currency by Bavink, by Mannheim, by MacCurdy in "The Structure of Morale" and by Lord Lindsay in "Religion, Science and Society in the Modern World". Dr. Barlow has his own angle of vision and his own contribution to make, and his central theme is one to be pondered in the light of many problems of current debate, such as the implications of the new Education Act or the fundamental causes of the world food situation. Despite some laboured passages, the book is written for the most part with a freshness and sincerity which enhance a challenge to complacent thinking about the growth of physical science and the material basis of life which society will disregard at its peril.

R. BRIGHTMAN

PHYSICAL CHEMISTRY AND BIOLOGY

Physical Chemistry of Cells and Tissues
By Rudolf Höber, with the collaboration of David I. Hitchcock, J. B. Bateman, David R. Goddard and Wallace O. Fenn. Pp. xiii + 676. (London: J. and A. Churchill, Ltd., 1945.) 42*s*.

THIS volume, the lineal descendant of the senior author's "Physikalische Chemie der Zelle und der Gewebe", follows rather similar general lines to the earlier work, but has been completely rewritten and thoroughly modernized. There are two sections on selected topics in modern physical chemistry; Hitchcock writes very clearly and competently on diffusion in liquids, reaction kinetics, thermodynamics, electromotive force and membrane potentials, and on some points in the theory of aqueous solutions. Bateman contributes about 120 pages on molecules of medium and large size, discussing fully the intermolecular forces, solid structures built from such molecules, and the properties of their aqueous solutions. These two sections constitute a very useful supplement to the usual medium-sized text-book of physical chemistry, skilfully introducing the reader to many modern and advanced topics of special value in biological research. From time to time, these chapters illustrate physico-chemical principles by reference to biological problems. While far from complete, this introduction will be of great value to those whose studies in physical chemistry for its own sake have not gone beyond a fairly early university stage.

On page 217, the real business of the book begins: a comprehensive review of many fundamental topics in biology with a thorough inquiry into the extent that these can be accounted for by physical or chemical mechanisms. It is by no means easy reading, for there is a great deal of detail, and in almost no case is there, as yet, a satisfactory theory as to how any single cell function is carried on. Every section is a mine of information on the analysis of cell and tissue functions, and on theories, past and present. Höber himself deals with absorption, secretion, permeability, membrane and cell potentials, narcosis, and the influence of ions on some functions and properties of cells. Perhaps the principal impression left with one who is not an up-to-date biologist is that, in these fields, despite the very great accumulation of experimental observations, the principal generalizations of fifty years ago still stand out as substantially sound; but that few, if any, valid and important generalizations have come to light in more recent times. Some modifications of theories of permeability prevalent fifty years ago are needed, but it is difficult to see any clear path through the maze of data now available.

Cell respiration is described by Goddard in some 70 pages, of which a part is given to a general discussion of non-biological oxidations. In contrast to the sections mentioned above, nearly all the analysis has been done in the last twenty-five years. It is evident that the oxidation of even the simplest organic compound in the living cell is a very complex process requiring a succession of steps, perhaps including at least one step involving synthesis to more complex organic compounds, before the final breakdown to carbon dioxide and water.

In the present state of knowledge, speculation plays a rather large part, and chemical equations with sometimes little to recommend them beyond bare possibility seem all that can yet be offered for the probable steps in biological oxidations. What part is played by organised structures inside the cells, in controlling oxidations, is very little understood; and it may be a long time before much is discovered on this fundamental subject, since oxidations of a complex nature take place in the simplest unicellular organisms, in which little visible structure is present.

It is in contractile tissues that the best chance seems to exist of discovering how the organised spatial arrangements of molecules control the fundamental chemical reactions, and how these structures are themselves affected by the reactions, so as to utilize their free energy and perform the characteristic functions of the living organs. Great progress has been made in understanding the processes occurring in contractile tissues in the last thirty or forty years, and Fenn's 78-page section gives an excellent account of this progress. The contractility of the myosin

molecule, and the manner in which its state of folding is affected by simple chemical substances, especially adenyl pyrophosphate, is a most important discovery, and is perhaps a long step towards the ultimate goal of understanding the interaction between the highly specialized tissue structures and the chemical reactions which accompany activity.

Of necessity, many topics in biology and physical chemistry are omitted, but the book gives an excellent account of the topics dealt with. Without entering into great technical detail, it indicates the principal experimental methods employed. All the contributors are very well equipped for their very difficult task; they write as a team, and the book is in no sense a collection of isolated chapters by independent experts, as are so many supposedly co-operative volumes published recently. It is a classic, a worthy successor to the older book, and it is likely to endure through further editions, though doubtless with many changes, so long as a leader of Höber's rare calibre is here to guide, and keen and competent experts can co-operate in the writing. It is scarcely necessary to say that no serious student of general physiology can afford to be without the book.

N. K. Adam

D.D.T.

D.D.T.: the Synthetic Insecticide

By Dr. T. F. West and G. A. Campbell. Pp. xii + 301 + 13 plates. (London: Chapman and Hall, Ltd., 1946.) 21s. net.

Among the outstanding scientific advances of the Second World War has been progress with insecticides, mainly because of the discovery of D.D.T. A long series of researches due to P. Laüger, P. Müller, H. Martin and their associates in the Basle laboratories of J. R. Geigy, S.A., has given us a relatively cheap agent which is effective against a wide, almost illimitable range of insects. This compound is white in colour, has little odour, is readily soluble in most organic solvents and possesses chemical and physical properties which allow of its incorporation in many formulations whereby the environments of varying types of pests can be penetrated. Lastly, practical experience and experimental investigation are reassuring about its safety when used intelligently.

It is now a matter of history how the 1942 collapse in the Far East threw an intolerable strain on the supply of natural insecticides, and it became a problem of the greatest urgency to obtain substitutes for derris and pyrethrum. D.D.T. was the answer, and its introduction shows applied scientific effort at its best, for a host of chemists, entomologists, toxicologists and other workers were concerned in the solution reached within the short space of a couple of years. The basic investigations had, of course, been in progress for many years since the Geigy workers, starting from a study of the La Roche product 'Isacen', recognized the value of certain essential chemical features which a compound must possess in order to exhibit insecticidal properties. These are (1) the *p,p'*-dichlorodiphenyl ether fragment, (2) a urea linkage, (3) sulphonic acid groups in certain positions which enable toxic elements to exert maximum effects.

From such investigations, which cannot be summarized here, the compound diphenyl-trichloro-ethane was hit upon as encouraging, and D.D.T. was synthesized eventually by condensing one molecule of chloral with two molecules of monochlorobenzene. The outcome was startling, for incredibly small amounts of this compound proved effective against the Colorado beetle, the common fly and a host of other nuisances. A list of the outstanding successes, both in the laboratory and in the field, would occupy a great deal of space, and one need only say that such pests as lice, mosquitoes and flies are killed off with ease and certainty to show the importance of the discovery. This effect is powerful in its immediate results, but it persists in some cases for long periods of time. Surfaces sprayed with kerosene solutions of D.D.T. kill mosquitoes alighting for several months after treatment. A fine deposit of minute crystals of D.D.T. on the walls of a room suffices to protect against flies for weeks, and indeed may increase in toxicity. The mere dusting of body surfaces with a powder containing 10 per cent D.D.T. is enough to keep down the louse population to extremely low numbers or even to eliminate it for three weeks or longer. Clearly there is an immense field of application here, not only where mass movements of men are concerned but also in the everyday matters of social intercourse. And this is by no means the whole story, for every month brings a fresh discovery of the value of D.D.T. against plant pests. At a time in history when food stocks assume a vital importance to nations the control of agencies which harass the agriculturist needs no emphasis.

It must, therefore, be urged that information about these insecticides should be available to the nation. The issues are so great that everyone concerned must be familiar with the uses of D.D.T., the best ways in which it can be employed, the risks to man and other animals, to plants and beneficial insects. There should be an appreciation of its limitations so as to anticipate disappointment and an ill-deserved reputation through uncritical application. Finally, liaison between the laboratory worker and the practical man needs to be maintained in a field of endeavour which is rapidly widening. The book by Dr. T. F. West and Mr. G. A. Campbell fulfils most of these requirements and is assured of the welcome it deserves. In it are to be found a careful record of the chemical, entomological and practical details which were available up to the time of writing in late 1945. Of course, progress is so rapid at the moment that already a good deal of new information needs to be added, and it is to be hoped that subsequent editions will attempt to keep pace with the onward sweep of knowledge. The scope of the book is shown by its two sections, the first part dealing with chemistry, formulation, toxic manifestations and incorporation of D.D.T. in paints, textiles, paper and other practical methods, the second portion discussing the use of D.D.T. against pests affecting man, animals and plants and the problems arising from such applications. A pleasing feature is the illustrations, which are vivid and highly instructive. The reviewer would suggest that summaries be added to each chapter in the next edition, whereby the busy person might quickly obtain the information he requires about the particular pest and its treatment. No doubt with the lifting of security restrictions in Great Britain there will be fuller reference to the British investigations which have been in progress. An omission of possible hazards arising from contact of D.D.T. with foodstuffs should be repaired as further information about this highly important matter becomes available.

G. R. Cameron

Atomic Energy for Military Purposes

The Official Report on the Development of the Atomic Bomb under the auspices of the United States Government, 1940–1945. By Henry DeWolf Smyth. Pp. viii+308+8 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 12*s*. 6*d*. net.

In *Nature* of December 29, 1945, p. 768, an article by Prof. N. Feather surveyed and discussed the official American report on the development of the atomic bomb which was issued under the title "Atomic Energy for Military Purposes" and was quickly to be known as the Smyth Report, after its author. The report was re-issued in Great Britain by H.M. Stationery Office. Now the Princeton University Press has published the pamphlet in book form "as a public service in accordance with its purpose as a non-profit organisation seeking to disseminate the results of scholarly and scientific research". No royalty or other compensation is being paid to the author.

Substantially the report is a re-issue of the original pamphlet. Minor changes have been made, and a paragraph on radioactive effects, issued by the U.S. War Department, has been included; an appendix consisting of the official account of the New Mexico test of July 15, 1945, has been added, and two further appendixes comprise the British Information Service statement, "Britain and the Atomic Bomb", dated August 12, 1945, and the Canadian Information Service statement dated August 13, 1945. There are also some photographs of the production plants and of the results of the explosion of the test bomb in New Mexico; and name and subject indexes are valuable additions.

This volume thus brings together the three official statements on the work on nuclear energy done during the War in a compact and convenient form which will be widely welcomed.

Papers of the Michigan Academy of Science, Arts and Letters

Vol. 28 (1942). Pp. xiii + 701. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1943.) 28*s*. net.

This volume consists of a series of papers under the divisions of botany, forestry, zoology, geography, geology, anthropology, folk-lore, history, language and literature, medical science and philosophy.

Five of the botanical papers deal with algæ from Haiti, Hong Kong, South-east United States, and the Philippines.

A paper on "Some Resupinate Polypores from the Region of the Great Lakes" by D. V. Baxter, University of Michigan, is the fourteenth part of a monograph on this subject; other numbers having dealt with material from Alaska, the Yukon Territory and the North West Territories. A large number of resupinate polypores of northern Europe and Asia are indigenous to the region of the Great Lakes. Furthermore the majority of porias which occur in Michigan, Minnesota and Wisconsin can be found throughout the United States. There are, however, certain variants and forms in different localities; some are correlated with the occurrence of different types of substrata, others macroscopic variations due to moisture conditions. Races or strains occur, and can be separated from each other largely on a basis of their growth reactions in media.

Among the zoological papers is an account of "Mass Hybridization between two Genera of Cyprinid Fishes in the Mohave Desert, California", by C. L. Hubbs and R. R. Miller, University of Michigan. The study is one of several by which the authors are attempting to determine how the distribution and speciation of the fishes of the American desert have been affected by the profound hydrographic changes that occurred during and after Quaternary times.

An Experimental Introduction to the Theory of Probability

By J. E. Kerrich. Pp. 98. (Copenhagen: Einar Munksgaard, 1946.) 8.50 kroner.

When Denmark was overrun by the Germans various British subjects were caught, Mr. Kerrich among them. He was interned in a camp under Danish control and spent part of his enforced leisure in coin-tossing experiments. This brochure, also completed in the internment camp, is written around the experimental results in an endeavour to provide a practical approach to the statistical theory of probability.

By an analysis of the observations, Mr. Kerrich introduces the idea of relative frequency as the basis of measurement of probability and shows how the elementary laws of addition and multiplication emerge as experimental facts for sequences of 'independent' events. He recognizes the logical difficulties but does not allow them to impede his progress, his main object being to provide an introduction to the study of probability for the average scientific student. The treatment is taken as far as the binomial distribution and the normal approximation to it.

Whatever views are held about the basis of the concept of probability there seems little doubt that students who meet it for the first time are helped to strengthen their faith by experimental work with coins or random numbers. Mr. Kerrich's brochure will be useful to such students, and his general approach could be studied with profit by teachers.

British Association for the Advancement of Science Mathematical Tables

Vol. 1: Circular and Hyperbolic Functions, Exponential and Sine and Cosine Integrals, Factorial Function and Allied Functions, Hermitian Probability Functions. Prepared by the Committee for the Calculation of Mathematical Tables. Second edition. Pp. xi + 72. (London: Cambridge University Press, 1946.) 10*s*. net.

The first edition of these useful tables was published in 1931, and reviewed in *Nature* of May 4, 1933. In the second edition the table of the factorial or gamma function has been extended from the recent computation to 18 places of decimals by Mr. S. Johnston. A few errors in the other tables have been corrected. Those who possess the first edition may obtain a list of these corrections on application to the Office of the British Association, Burlington House, London, W.1. The elaborate introduction that appeared in the first edition has been greatly reduced; the portions that have been deleted are those concerning the history of the Committee, the formulæ used in the computation of the tables, bibliographical references, and an account of the Hermitian *Hh* functions. What is left is the portion directly useful to the user of the tables. Computers are deeply indebted to Prof. E. H. Neville and his colleagues for their arduous labours.

THE NATIONAL PHYSICAL LABORATORY AT TEDDINGTON

ON June 19, 20 and 21, the National Physical Laboratory, Teddington, was 'open' to visitors for the first time since 1939. Visitors on the first day included the delegates to the Royal Society Empire Scientific Conference, on the second, members of the staffs of the universities and on the third, representatives of the Services and industry.

The National Physical Laboratory was founded in 1900 under the control of the Royal Society; since 1918 it has been a part of the Department of Scientific and Industrial Research, but the Royal Society still appoints the General Board and the Executive Committee of the Laboratory. The prime aim for which the Laboratory was founded was to assist British industry by research and test work in various physical and engineering fields, notably the accurate determination of physical constants, the establishment and maintenance of precise standards of measurement and the testing of materials and instruments. Routine testing and the investigation of particular industrial problems thus constitute a necessary and valuable part of the work. But, in addition, programmes of fundamental research in appropriate fields are carried out, and it is fair to say that this aspect of the Laboratory's services to science and industry has assumed, and is assuming, greater importance year by year.

The scope of the work undertaken is indicated by the names of the ten Divisions of which the Laboratory is comprised, namely, Aerodynamics, Electricity, Engineering, Light, Mathematics, Metallurgy, Metrology, Physics, Radio and Ship Divisions. On the 'open days' more than 250 exhibits were on show, illustrating the work of all Divisions. In a brief article it will be impossible to do more than mention a few of these items, which may, however, serve as examples of the permanent work of the Laboratory and of recent developments there.

The Metrology Division of the Laboratory is responsible for carrying out the periodic statutory intercomparison of the British Standards of mass and length. Among the exhibits was a special balance constructed for the comparison of the Imperial Standard Pound and its copies, and similar work on kilogram standards, which shows promise of an accuracy approaching one part in one thousand million.

Two standard quartz clocks designed and constructed at the Laboratory are in operation in the Electricity Division. Such clocks consist essentially of a plate or ring of transparent natural quartz, kept vibrating by suitable valve circuits; as a means of measuring frequency or time, they are capable of an accuracy of the order of one part in a hundred million. During the War, the Laboratory co-operated in the work of checking the day-to-day accuracy of the Royal Observatory time signals, with a view to increased accuracy in the measurement of time.

Two Divisions of the Laboratory use the technique of wind-tunnels in their investigations. In the Engineering Division, a supersonic tunnel with a working section eleven inches square is used for experiments on projectile models up to two inches in diameter, at air speeds up to $2\frac{1}{2}$ times the velocity of sound. This tunnel was the only large supersonic tunnel possessed by the Allied Nations for almost the whole period of the War, and has been of value not only in relation to problems of ballistics and high-speed flight, but also in the general development of the science of gas dynamics.

Several small high-speed wind tunnels in the Aerodynamics Division have been used for the study of problems of flight at speeds approaching that of sound. In this region, which aircraft speeds are now entering, the compressibility of the air becomes an important factor, one consequence being the formation of shock waves which greatly increase the resistance to the progress of the aircraft. The aim of one part of the investigation is, therefore, the postponement to as high a flying speed as possible of the formation of shock waves.

Another means of attaining greater efficiency in flight, by the reduction of wing resistance, is to design the wing section so that the flow in the very thin 'boundary-layer' of air near the wing surface remains non-turbulent over as much of the surface as possible. Important theoretical work has shown how to design wing sections to have these characteristics, and wind tunnel tests have shown that the predicted behaviour of the wing may be realized in practice if the surface is smooth and free from waviness. A further method is the employment of suction to control the air-flow near the surface; an experiment on this problem was in progress in the largest wind-tunnel (working section 13 ft. × 9 ft.) at the Laboratory.

Another aspect of the work of the Aerodynamics Division concerns the study and prevention of aero-elastic oscillations of the wings and other parts of aircraft, known as flutter. The stability of the aircraft as a whole when in flight is also studied, and linked closely with this is the problem of controlling the aircraft by means of the ailerons, elevators and rudders. Wind tunnels are an indispensable and major part of the equipment for the experimental study of these problems, but a further large item known as a whirling arm is also used for the study of the rotational motion of the aircraft. The latest piece of equipment of this kind, consisting of an arm of 30-ft. radius which revolves at a speed of about half a revolution per second, was completed during the War.

The work of the Ship Division in making tests on models of ships built for the nation's merchant navy is well known. The two tanks and propeller-testing tunnel were in operation, and it was possible to see every stage in the process of model-making and testing.

An automatic pitching recorder used at sea, and a vibrograph and accelerometer which is much used to obtain vibration records on ships at sea, were also on view. Following investigations on ship vibration, it has been found possible to warn naval architects in the early stages of design if and when bad vibration is likely to occur, and to suggest the fundamental changes which must be made to avoid it.

Other investigations at the Laboratory employing model technique include the use of an estuarial tidal model to study means of preventing the silting of the navigation channel in the estuary of the Tigris and Euphrates Rivers, and ventilation experiments on a quarter-scale model of the projected new debating chamber of the House of Commons.

The sound section of the Physics Division is provided with an acoustics laboratory of highly specialized construction, where the investigation of problems of architectural acoustics, the measurement of noise and the testing of instruments are carried out

in sound-insulated test-rooms. Much attention has recently been given to the measurement of the sound transmission through various forms of building construction in connexion with housing schemes. Laboratory measurements of the sound insulation of suitable party-wall structures, however, provide only part of the information required for effective design and must be supplemented by measurements in completed houses. Investigation of methods of reducing noise in factories, etc., also require measurements to be made on the site. For such purposes, a mobile acoustics laboratory has recently been built for the Laboratory, permanently fitted with equipment for the production of suitable sounds for test purposes and with microphone and amplifier equipment for the measurement and analysis of noise.

The Radio Division has carried out research on such subjects as the propagation of radio waves, the origin and nature of 'atmospherics' and the utilization of radio technique for meteorological purposes. The research on propagation has included the systematic measurement of the critical characteristics of the ionosphere, as determined by the reflexion of pulse transmissions. The results of this continuous study of ionospheric conditions are combined with research on the mode of propagation of radio waves through the ionosphere, and used to predict the optimum conditions likely to pertain for communication and broadcasting purposes.

In the Metallurgy Division, the techniques of electron and X-ray diffraction are being utilized in studying metallurgical problems. The researches include the study of the atomic structure of alloys, in particular iron-nickel-chromium, and an apparatus has been constructed for obtaining X-ray diffraction patterns from block specimens of metals at temperatures up to 1,000° C. In order to follow the rate of phase changes, electronic methods of recording the X-ray patterns instantaneously with the aid of Geiger counters are under development. Research is also in active progress on the changes in atomic and crystalline arrangement of metals under stress, and a new combined X-ray and tensile testing machine has been developed for special study of the atomic mechanism of deformation of metals.

Other metallurgical problems are studied with the aid of the electron microscope at the Laboratory. In this work the metallic specimen is first highly polished and then etched in an appropriate reagent, so that the various constituents are attacked differentially and are revealed as geometric features on the surface of the metal. A cast of the surface is then made in the form of a thin film which is examined in the electron microscope, a picture being obtained in terms of the varying thickness of the film. In spite of the indirect method of examination, pictures have been obtained in the electron microscope at magnifications of 10,000 diameters which are superior in definition to those obtained in optical microscopes at 1,000 diameters magnification.

A special laboratory in the Engineering Division is equipped for the study of the creep of metals, that is, their deformation under stress at high temperatures. About forty special creep-testing machines, designed and constructed at the Laboratory, are in operation. The development of materials which will behave satisfactorily at high temperatures is of particular importance in connexion with modern heat engines, especially the gas turbine as used for jet propulsion of aircraft. During the War, the essential tests of nearly every new heat-resisting material used in British aircraft engines were made at the Laboratory.

Mention has been made of the work of the Laboratory in the establishment and maintenance of standards of measurement in various fields. Complementary to the work on primary standards of length, mass, etc., is the testing of gauges and other instruments for use by industry in precision measurements. In the Metrology Division all kinds of precision measuring equipment, including optical projectors (for the examination of form or contour), engineers' small measuring tools and gauges, are tested and new types are investigated. Equipment is available for the complete examination of all types of gears, splines and gear-cutting hobs, and a standard leading-screw lathe is used for correcting leading screws of any British or metric right-hand pitch.

In a similar way the Engineering Division carries out the accurate calibration of tension and compression testing machines used for routine tests on engineering materials. For this purpose a dead weight primary standard of 50 tons capacity is now available and is rapidly becoming recognized as the primary standard for the calibration of testing machines, not only in Great Britain, but also throughout the Empire.

Space does not permit the mention in further detail of calibration work carried out at the Laboratory in various other fields, for example, thermometers, barometers and volumetric glassware.

In the sphere of optics, the Light Division investigates problems connected with the design of lens systems and the components of optical instruments, and one of the chief services performed during the War by the Division was the regular testing of thousands of optical instruments for the Service departments.

Among the exhibits in this Division was the 'Universal' lens interferometer, an instrument which gives a definite measure, in terms of physical units, of the departure from perfection in the definition of, say, a telescope or camera lens. Another was a colorimeter, designed at the Laboratory, by means of which colours are analysed in terms of three standard spectral colours.

In the High Voltage Laboratory, part of the Electricity Division, demonstrations were given of sparks produced by a two-million volt impulse generator and a power-frequency supply of one million volts. Much of the work of this section is concerned with tests on high-tension transmission cables, transformers, etc., in order to determine the ability of such equipment to withstand abnormal surges, such as in thunderstorms.

The radiology section of the Physics Division has performed a valuable service to the nation by its work on the estimation of health hazards of workers using X-rays and radioactive materials. The radiations to which persons are exposed during working hours can be assessed by means of the blackening of photographic films worn by the workers. After exposure, the films are processed and the blackenings compared with those of control films from the same batch which have been given known quantities of radiation. In the case of workers dealing directly with radioactive materials, additional tests have been devised for the determination of the amount of radioactive material which may have accumulated within the body.

The most recent Division to be formed at the Laboratory is that of Mathematics, which was

created in 1945 to assist Government departments and industry with advice on mathematical matters and with computational services. The tabulation of mathematical functions of general utility, the application of statistical methods to research problems, and the development of new computing methods and machines are among its activities. A comprehensive range of modern calculating equipment, including Hollerith punched card equipment, is installed at the Laboratory, and the Division has also the use of a differential analyser.

HEREDITY AND VARIATION IN MICRO-ORGANISMS

COLD SPRING HARBOR SYMPOSIUM

WITH the meeting held at the Long Island Biological Laboratory during July 2–12, the series of Cold Spring Harbor Symposia on Quantitative Biology, interrupted since 1941, has started again. This year the theme was heredity and variation in micro-organisms; papers and discussions will be published as volume 11 of the Symposia. The meetings were attended by a number of biologists from Britain, France and Denmark, who joined in discussion with nearly a hundred of their American colleagues.

One of the main objects of the symposium, the finding of common grounds of interest between virologists, bacteriologists, mycologists and geneticists, was fully achieved: indeed, the languages spoken by these formerly distinct groups are gradually merging. It was evident that in a great many fields of research considerable progress had been made since the Missouri Botanic Garden Symposium held in Saint Louis in February 1945 (see *Nature*, January 26, 1946, p. 95).

The work reported at the present symposium may be grouped under three main headings with, of course, much overlapping. The first is the study of the mechanisms of heredity and variation (formal genetics). The techniques and methods of approach of classical genetics are applicable wherever heredity and variation have a particulate basis, irrespective of whether the particles are organised into chromosomes. These possibilities have been skilfully exploited by groups of workers dealing with such suitable material as bacteriophages and their hosts. Among the outstanding results reported at the symposium was the demonstration of exchange of properties between bacteriophage particles belonging to different strains and grown together in the same cell. The number of mutant types known in bacteriophages is still somewhat small, most of them being concerned with host-range and with rapidity of lysis (the latter recognizable from the appearance of the plaques produced). By the use of special techniques it has been possible to determine the mutation-rates for a number of these genetic characters in phages: they seem to be of the same order of magnitude per generation as in higher organisms, although the rate per unit of time is, of course, vastly greater. Where viruses of different genetical constitution are grown together, the results of competition between then can be studied statistically. The size and approximate shape of bacteriophage particles has been investigated by electron-microscopy: some of them appear to be tadpole-shaped, with a 'head' approximately 500 A. in diameter and a 'tail' which may be 1,000–2,000 A. long. Similar studies have been made on animal viruses; but there is still considerable doubt as to the particle-size and shape of even some of the best known plant viruses, such as the tobacco mosaic virus, the difficulty here being to decide what relation exists between the state of the virus in the intact leaf and its appearance in electron-micrographs of particles prepared by different methods of purification.

In bacteria, some work has been done on mutants of visibly different colours, but the most promising line of investigation seems to be the study of bacterial mutants which lack the ability to synthesize some particular chemical substance (for example, an amino-acid) and which consequently will not live on a 'minimal' medium, but will grow on such a medium when the 'missing' substance is added to it. One of the most outstanding pieces of work reported at the symposium was the demonstration that when two bacterial strains which differ in two or more such nutritional requirements are grown together, they may give rise to bacteria having fewer or none of these requirements (that is, able to grow on the minimal medium alone). It does not seem that this result can be explained by the occurrence of multiple independent mutations in the same clone, the probability of such an event, calculated from the known mutation-rates, being far too small. The phenomenon is not yet understood, but its elucidation may open up great possibilities and link up with the analogous discovery in bacteriophages mentioned above. It would not be surprising if this elucidation threw some light on the nature of crossing-over in higher organisms.

It emerged from the discussions that the old alternative between sexual and asexual reproduction may well be a matter of degree, and that new terminologies may have to be developed to cope with the description of the formal genetics of micro-organisms: heredity seems to have a particulate basis in all organisms, but different ways of assorting and segregating particles may operate in different groups. In the higher organisms we have the organisation of such particles into chromosomes and the alternation of meiosis and fertilization. But many other mechanisms may exist, especially in the lowest forms of life, and indeed one of these, known as heterokaryosis (based on segregation and recombination of whole nuclei in multinucleate cells), has long been known in certain fungi (although its genetic significance is only beginning to be apparent), and a similar mechanism may operate in bacteria.

The second stimulating topic of the symposium was that of the nature of cytoplasmic 'self-duplicating' particles ('plasmagenes') and their relations to the nuclear genes. Most of the evidence continues to come from studies of 'adaptive' enzymes in yeast and bacteria and from work on plasmagenes in *Paramecium*, particularly those responsible for the 'killer' reaction. An interesting recent advance is the discovery that an extract of yeast cells adapted to ferment a particular sugar will increase specifically the speed of adaptation in non-adapted cells. The similarity between this result and the transformations of pneumococci studied by Avery and McCarty is evident. Another important advance is the discovery that the rate of multiplication of the plasmagene responsible for the production of the 'killer' substance

in *Paramecium* is to a considerable degree independent of that of the nuclear genes and of the cell, so that by varying experimentally the rate of division of the cells the number of particles per cell can be controlled. Studies such as these have provided material for various working hypotheses on the relationships between genes and plasmagenes, and a good deal of discussion took place on these matters. Without going into details, it seems to be very significant that the study of the cytoplasm is no longer 'taboo' for the geneticist. On the contrary, he now approaches it with the feeling that from it classical genetics can be broadened and completed in precisely that part where an impasse had been reached, namely, the relations between the activities of the genes and the biochemistry of the cell as a whole.

A third topic of the symposium was the genetical control of biochemical reactions. To the great amount of work done in recent years on the fungus *Neurospora*, mainly by Beadle, Tatum and others at Stanford University, closely parallel results with bacteria have now been added. The technique of 'blocking' chemical reactions at specific points by means of specific mutations (so as to produce strains deficient in the ability to synthesize a particular substance) proves to be a tool of increasing usefulness in the analysis of these reactions. The synthesis in the cell of most types of organic compounds takes place in many steps, each of which may be 'blocked' by a mutation leading to the loss or inactivation of a specific enzyme. Thus many mutations leading to the same end-result (a particular 'nutritional deficiency') may exist, each acting on a different step in the same biochemical synthesis. Very large numbers of such mutations have now been obtained in *Neurospora* by the use of X-rays, ultra-violet radiation and chemical agents. Many of these are undoubtedly 'point-mutations' at a single locus, but others with complex effects may be structural chromosomal changes such as small deletions, which cannot as yet be distinguished with certainty from the former category. Whether this type of biochemical genetics will only be, from now onwards, a tool for the biochemist, or whether it will also produce fundamental results in genetics and cell physiology, is a matter for the future.

G. PONTECORVO
M. J. D. WHITE

TORPEDOES: THEIR USE AND DEVELOPMENT DURING THE WAR*

By CAPTAIN W. W. DAVIS
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THE torpedo designer has in some ways an even harder task than the aircraft designer. He must produce a propulsive system that is completely self-supporting and self-contained; in other words, he must carry all the air with him that he wishes to use; this problem is unique—an aircraft engine, a steam engine, a marine steam or diesel engine can and does draw unlimited quantities of air from the atmosphere, as it were for nothing. In very round figures, for each ton of fuel consumed, be it petrol, oil or coal, these engines use at least 15 tons of air. The torpedo designer, on the other hand, has to carry all this air with him. So his problem is more conditioned by the amount of air he can carry than the amount of fuel. Furthermore, the torpedo designer is very restricted for space, the weapon must be small and easily maintained, and by reason of his special problems the torpedo designer cannot draw to any very great extent for technique on the general engineering industry of Great Britain.

In a nutshell, the problems confronting the designer of torpedoes are as follows:

(i) He must increase the chance of his weapon hitting its target by reducing the time which it takes to reach the target—in other words, it must be very fast. The latest British torpedo engine develops 465 h.p. and can drive the torpedo at 50 knots. Its weight is only 223 lb.

(ii) The torpedo must be capable of going great distances, as the farther away you are from your enemy at the moment of attack the less likely he is to see your torpedo and destroy you before it has been launched. This is particularly important in the case of submarines, the purpose of which is to deliver an unseen attack. Therefore the torpedo must have a considerable endurance. If the designer achieves this, he can make use of additional devices, such as patterning devices, which will enable the torpedo to turn and recross the track of the convoy a number of times, thus much enhancing the chance of a hit.

(iii) The torpedo must be trackless, so that the ship does not see the torpedo in time to avoid it.

(iv) The torpedo must carry as big an explosive as possible to ensure that one hit will either sink outright any vessel or very seriously damage it.

(v) The torpedo must be accurately controllable in depth and direction. A few feet error in depth might cause the torpedo to pass harmlessly under the ship attacked, and a few degrees error in bearing at long distances would cause it to miss by many yards.

(vi) Finally, what is perhaps most important of all, the torpedo must be simple, easy and safe to maintain, easy to use and robust. This is particularly important as at sea in small ships it gets rough usage, and when used from aircraft it must withstand the shock of entry into the water. An aircraft torpedo weighs nearly a ton, and it will be appreciated there is considerable shock when it enters the water at something like 300 knots or more.

Developments

How, then, have we and other nations tackled these problems?

How has the inherent disadvantage of this weapon, namely, the long time of flight, been tackled? The ideal is for the torpedo to travel at very great speed in the air like a shell and then plunge into the water just short of the target and hit it underwater. The Germans had done some preliminary work on a flying torpedo—it was propelled in the air by rockets for a predetermined distance and then dived into the water. They had not, however, got very far, and it is evident that it would not have reached fruition for some years. We in Britain had realized this was more of a long-term development and consequently guided our developments on improving the under-water speeds. The chief limiting factor in speed is

* From a discourse at the Royal Institution on June 14.

the amount of power that can be transmitted through the propellers, which by virtue of the diameter of the torpedo are limited in size. Above a certain horse-power, cavitation sets in at the tips of the blades and the propellers cease to be efficient. Jet and rocket propulsion under water have been considered; but their main disadvantage is that at speeds likely to be achieved their efficiencies are only about one tenth of the orthodox propeller system, and we must reluctantly in the interests of overall efficiency put this aside for the moment. However, by increasing the number of blades of the propeller, by using special steels and redesigning it, we find that it is practicable to drive the existing type of torpedo up to about 50 knots. In regard to engines, a four-cylinder radial type is favoured in Britain, whereas the Germans in their later torpedo adopted a turbine capable of an output of 450 h.p. which makes for more smooth running but thermally is not so efficient as our types of engine.

How has the problem of making the torpedo go great distances at great speeds been tackled? As I have indicated, the great handicap is carrying the air, of which only about one quarter by weight, namely, the oxygen content, is of use for burning with our fuel. Consider again the pre-war British torpedo—nearly half the volume of it is devoted to the air chamber, namely, about 23 cubic feet. This air chamber has to be very strong to withstand the high air pressure and consequently weighs just over 1,200 lb., which is about one third the total weight of the torpedo. The weight of air carried even when compressed to a little more than 200 atmospheres at normal temperatures in this large chamber is only about 360 lb. Of this 360 lb. only about one quarter by weight is useful oxygen. The designer's and engineer's dream is some means of carrying the oxygen at a less price than they have to pay in the orthodox air torpedo. Their thoughts turned to various chemicals which carry, as it were, large quantities of spare oxygen, or better still, they have been looking for a single liquid or solid propulsive, thus obviating the necessity for carrying fuel. Their thoughts also turned to using oxygen instead of atmospheric air in the air vessel—liquid oxygen they had to discard on the grounds of maintenance difficulties in weapons that have to remain ready for instant use for months on end without any attention.

The accompanying table indicates what gains are likely to be achieved. By using gaseous oxygen we have between four and five times the amount of oxygen to burn, by using 80 per cent hydrogen peroxide we have about ten times as much, and by using 100 per cent nitric acid we have nearly seventeen

COMPARISON BETWEEN OXYGEN CARRIERS IN TORPEDOES

Oxygen carrier and conditions	Amount carried per cubic foot of space in container	Oxygen available per cubic foot of space
(1) Atmospheric air at 3,100 lb./in.^{2} (i.e., 207 atmospheres)	15·4 lb.	3·6 lb.
(2) Gaseous oxygen at 3,100 lb./in.^{2} (100 per cent purity)	17·5 lb.	17·5 lb.
(3) Hydrogen peroxide solution at 80 per cent concentration	71 lb.	37 lb.
(4) Nitric acid at 100 per cent concentration	94 lb.	60 lb.
or at 70 per cent concentration	89 lb.	39 lb.

times the oxygen available in an orthodox torpedo. We have to take into account the heat generated in the decomposition of these chemicals, the method of controlling the release of oxygen, the temperatures the engine will stand, and many other factors. But nevertheless it is evident that startling advances are possible. Again we are up against the problem of simplicity; it is no good having just a laboratory-made and -maintained engine in a torpedo—it must be simple, safe and robust.

The Germans devoted their main effort to producing a hydrogen peroxide torpedo, and by the end of the War were in an advanced stage of development with this. They had produced an experimental torpedo. It had an anticipated performance of about two to two and a half times our previous best and about three times their previous best. Nevertheless, they had not fully solved the problem of simplicity, safeness and reliability, and some years intensive work would have been required before these difficult problems had been solved. They used 80 per cent hydrogen peroxide, known as 'Ingolin', with phosphoric acid and oxyquinolene stabilizers to prevent it decomposing. A catalyst known as 'Helman', which consisted of 80 per cent hydrazine hydrate and 20 per cent ethyl alcohol to which is added 0·5 gm. of copper per litre, was used for decomposing the hydrogen peroxide. The fuel used is a by-product of the coal distillation industry known as 'Dekalin', which is short for decahydronaphthalene ($C_{10}H_{18}$).

We in Britain had tried diluted gaseous oxygen, but had discarded it for the then valid reason of unreliable oxygen plants. Oxygen, however, has certain disadvantages—the presence of oil in pipes is liable to cause an explosion if oxygen comes into contact with it, and consequently special lubricants have to be used. The Japanese followed our lead in the 1920's and developed on the whole a very good oxygen torpedo which they used with considerable effect during the War. Apart from our own 24½-in. torpedo, which was in limited use, it was a bigger torpedo than any other; its dimensions and performance were as follows: diameter, 24 in.; weight, 6,300 lb.; speed, 50 knots; range, 22,000 yd.; explosive, 1,200–1,700 lb. T.N.T. In total weight it was more than half as heavy again as our torpedoes and required more space for stowage on board ships. It is, however, a very formidable weapon, which in speed, range and explosive is considerably in advance of all atmospheric air torpedoes.

Oxygen holds out, I believe, for the future great hopes of much-improved performances without materially sacrificing the all-important quality of simplicity and ease of maintenance.

Nitric acid suggests the greatest advances of all. We had in the years before the War done considerable work on this, but had not reached the stage of tackling the difficulties of stowing it safely in ships. Concentrated nitric acid is a dangerous fluid to have on board when a ship is in action and liable to be hit.

To sum up, all these alternatives to compressed air introduce added complications, certain dangers to handle, and added maintenance. These have to be carefully balanced against the great improvements in performance that their employment will bring about.

To turn to our third point, the importance of tracklessness. The Germans set great store by this, and adopted widely the poor performance ordinary

electric battery torpedo. It relies for its stored energy on the straightforward lead accumulators and is, of course, completely trackless, due to the absence of any exhaust gases. To achieve tracklessness with the ordinary type of torpedo, it is essential to remove or much reduce the nitrogen content of the exhaust gases. With hydrogen peroxide or pure oxygen there is no nitrogen and only small quantities of other insoluble gases in the products of combustion, and therefore the torpedoes are virtually trackless.

Our fourth point stipulates that the explosive must do the maximum damage. There are two ways of doing this: first to increase the power and weight of explosive, and secondly to arrange for the explosion to take place under the bottom of a ship, which is its most vulnerable part, and not on its side. An explosion under the bottom is liable to break a ship's back and possibly in extreme cases sever it into two parts. We introduced during the War an improved explosive which increased the damaging effect of our warheads by 25 per cent. The Germans kept to their hexamite, which while rather stronger than T.N.T. is not so powerful as our latest explosive. To make a torpedo explode under a ship's bottom is not an easy problem. Modern ships are degaussed or demagnetized, so it is of no avail to rely solely on the ordinary permanent magnetic field surrounding a ship to actuate the firing mechanism. On the other hand, the presence of a ship will cause a distortion of an artificially produced magnetic field carried by the torpedo itself, and by this means a pistol can be devised to fire the explosive charge as it passes under a ship. Both the British and the Germans used what are known as these non-contact pistols with considerable success during the War. In very round figures, a torpedo exploding under and within a few feet of the bottom of the ship will probably do about twice the damage of a similar one hitting its side.

Our fifth point lays down that the torpedo must be accurately controllable for depth and direction. The Germans decided that they would introduce a listening torpedo which 'listened' for the noise made by a ship's propellers, and then through a complicated system of relays automatically steered the torpedo towards the noise. We knew this as the 'GNAT', and it was countered by a ship towing an artificial noise-maker called the 'Foxer' which attracted the torpedo and caused it to pass harmlessly astern. It is evident that a device of this type is liable to defeat any manœuvres a ship may take. But to allow the listening gear to work, the torpedo must not make too much noise itself, and the German system entailed reducing the torpedo speed to 24 knots.

However, the steering of the torpedo when it is, as it were, on its own is effected by a gyroscope. If the torpedo tends to wander off its set course the gyro shows this, and through a system of relays the rudders are worked and the torpedo brought back on to its course.

The sixth point lays down that the weapon must be simple, safe and easy to maintain. In submarines it has to remain for months on end exposed to the sea with no attention, and yet has to run accurately and well when the chance, often a fleeting one, presents itself. In surface ships, especially smaller ones, it must not be affected by rough seas drenching it with water, and for aircraft the airmen naturally call for a weapon that requires little more attention than does a bomb. In the Services, war brings inevitably vast expansions to the fighting forces, and it is neither possible nor practicable to have very many highly skilled and trained artificers to care for all these weapons. The torpedo has to be run with dummy heads for practice in peace and war, so that we can learn how best to use the weapon; and therefore any complicated chemical system must be safe, not only while in storage on board and during its run, but also when the torpedo is being recovered and prepared for another run—this has so far not yet been solved with such chemicals as hydrogen peroxide and nitric acid. Therefore it is our aim to ensure the maximum of simplicity, and we accept considerable sacrifices to achieve this. That is the reason why at the beginning of the Second World War the nations of the world, with the exception of the Japanese, accepted the ordinary straightforward torpedo running on highly compressed atmospheric air.

Organisation for Developments

The organisation adopted for development is of such importance that it merits comment. Our investigations in Germany revealed some very interesting facts. In Germany they had six large establishments costing many millions of pounds and employing a very great number of scientific men, engineers and technicians devoted entirely to torpedo developments. These establishments were planned after the First World War, and the building of them started very shortly after the Nazis' accession to power in 1933. No money was spared—more than 12,000 men all told were employed on this work, and in consequence an impressive amount of development was done. Thanks to a special field organisation, we captured four of these establishments intact well in advance of our Army some days before the end of the War, so we have a fairly complete knowledge of their work. There were, however, two major defects in their organisation which we should take to heart. The relations between the German Navy and Air Force were bad. We found many parallel investigations—neither party knew what the other was doing, and there was no wholehearted interchange of information on the development of weapons which are common to aircraft, ships and submarines. In Britain, the Admiralty are responsible for the development of torpedoes and certain other weapons for the Royal Air Force as well as the Navy. There is a very close and real co-operation between the two Services; Air Force officers serve in naval experimental establishments and so on.

The second point is that the Germans employed on development and research were not integrated nearly enough with the users, that is, their naval officers, with the result an immense amount of work was wasted and their vast effort was most uneconomically used. An example is interesting; German scientific investigators put much work into developing a non-contact pistol for the warhead of a torpedo which was worked by the shadow cast by a ship—in other words, when a torpedo passed under a ship the explosive warhead was detonated by the shadow cast by the ship. It never seemed to have occurred to these investigators, and no German naval authority seems to have informed them, that the torpedo is primarily a weapon for use at night, and therefore a shadow-operated pistol would be of little value.

The correct organisation must be for the scientific investigator, the engineer and the naval or air force officers to be closely integrated and work as a team on any project from start to finish. The user can say what is wanted, and up to a point what is practical

—the scientific worker and engineer can point to the possibilities and state what is scientifically and technically practicable. In very general terms this is the method adopted in Great Britain ; the scientific worker goes to sea, carries out trials: the naval officer comes in from sea, and is at hand to advise and suggest.

Finally, what of the future ? May I suggest some guiding rules by which we must abide.

(1) We must never let any segregation take place of the scientific worker, engineer and naval officer—with the tremendous advances possible each must contribute his share—each must understand and realize some of the other's outlook, his difficulties, and his general approach to a subject. With the increasing complexity of scientific and technical advances, there will be an increasing tendency to segregate ; I suggest this must be strongly resisted.

(2) We must learn from the Germans, and never starve our forces of adequate numbers of scientific and engineering specialists of a high quality. If we do starve our Services we shall find ourselves at a great, and may well be disastrous, disadvantage in having to fight and use outmoded weapons and devices. Numerically we cannot have great numbers, but what we have must be of superlative quality. In technical and scientific achievement we must be second to none.

RUSSIAN WORK ON CHEMICAL INDUCTION IN ADULT ANIMALS*

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The present article was written in response to that by Dr. G. Levander[1] describing some of his interesting experiments on the development of cartilage, bone and other tissues by means of induction in adult animals. The author connects his investigations with the problem of induction in the sense of Spemann, who considers that in the embryo induction is caused by chemical substances. Unfortunately Dr. Levander seems not to be aware of the studies on organisers in adult animals which has been carried on in the U.S.S.R. since 1928 ; the purpose of this report is to summarize this work.

In the embryonic period, the tissues and organs are labile, and very easily react to stimuli by morphogenesis. The investigation of the chemical factors in morphogenesis at this stage is therefore difficult. The merit of the late Prof. N. V. Nassonov lies in having performed experiments with organisers on adult animals, with fully developed, histologically differentiated and functioning organs. It is evident that the formative reactions in a developed animal would be more limited and specific than those of an embryo ; but if we regard the whole life of an organism as one process, in which morphogenesis ceases only with death, we can expect that such studies will contribute a great deal to the general problem of chemical nature of morphogenetic substances.

Nassonov showed that regeneration is not necessarily dependent on wound stimulation. The development of additional organs in axolotls can be obtained by tight ligature of an extremity, without amputation. The disintegration products of the tissues produced in this way cause the development of additional extremities[2]. However, in these experiments a physiological enfeeblement of the organ takes place. If the organ is removed, and whole or desiccated regeneration buds, bits of organs and tissues of axolotls and other animals are inserted under the skin of a normal extremity, at the locus of the insertion additional formations develop, ranging from outgrowths of skin to entire extremities with skeleton, muscles and nerves[3].

It appeared that the insertion of different organs and tissues under the skin of the axolotl causes different degrees of morphogenesis, the greatest effect being produced by the cartilage and the least by gills. The disintegration of the inserted tissue is an indispensable condition for this stimulus. If the tissue grafts in and does not disintegrate, morphogenesis is absent. The grafted tissues, therefore, contain substances which cause morphogenesis upon interaction with the tissues of the host.

On the advice of Prof. N. D. Zelinsky, Nassonov inserted products of chemical hydrolysates of tissues under the skin of axolotl extremities, and in a number of cases he obtained two- and tri-dactyl appendages at the locus of insertion[4]. The premature death of N. V. Nassonov interrupted his work in 1939.

Since 1939, I have been at the head of N. V. Nassonov's Laboratory of the problem of organisers of the U.S.S.R. Academy of Sciences. Together with Academician Zelinsky and other collaborators, we are continuing by means of complex biological, biochemical and chemical methods the study of the problem of organisers in developed animals.

N. A. Kusmina[5] has made precise the temperature limits within which the cartilage, inserted under the skin of an axolotl extremity, retains its morphogenetic action, and has shown that the loss of this capacity at temperatures above 45° C. is not connected with inactivation of its proteolytic ferments. V. E. Sokolova has shown that this heating of the cartilage does not render it inaccessible for the enzymes of the host, but, evidently, changes the dynamics of the hydrolysing action of the tissue ferments. It is, therefore, necessary to study the disintegrating action of the ferments. A. A. Peredelsky[6] has studied the relation between the regeneration effect and the histolysing property of the regenerating epithelium and has found that the cutis acts as a physico-chemical barrier, inhibiting the penetration of the histolysing substances into the zone of amputation from the regenerating epithelium. Kusmina[7] has obtained additional formations after insertion of muscular tissues, which gave no effect in the experiments of Nassonov. The character of the formations depended on the region of the inserted muscle. Nassonov had established the existence of regions in the axolotl body differing in their morphogenetic potencies. Sokolova showed[8] that these differences are dependent upon the degree of activity and the total amount of tissue ferments. D. M. Fedotov, A. B. Silaev and A. A. Peredelsky[9] have studied the morphogenetic action of carcinogenous substances.

An extensive series of experiments has been made on the chemical side of the problem of organisers. Recently, A. B. Silaev, working in the chemical laboratory of Zelinsky in the University of Moscow, has carried out an extensive series of experiments on the alkaline and acid hydrolysates of organs, tissues and whole axolotls[9]. The biological value of hydrolysates has been tested in our laboratory by Fedotov and Kosheleva. Among the numerous hydrolysates tested, the products of the prolonged hydrolysis of

* Manuscript revised and condensed by Dr. C. H. Waddington.

Fig. 1

cartilage in 25 per cent formic acid and 1 per cent hydrochloric acid were exceptionally effective. A month after the insertion of products of cartilage hydrolysis in 25 per cent formic acid, all operated axolotls had rudiments which developed into 4-digitate and 5-digitate legs (Fig. 1). In a number of cases, two and three additional legs were formed at the loci of insertion. The new legs were frequently of the same size as the old ones and took their place (Fig. 2). Similar results were obtained also upon the insertion under the skin of axolotls of products of cartilage hydrolysates in 1 per cent hydrochloric acid,

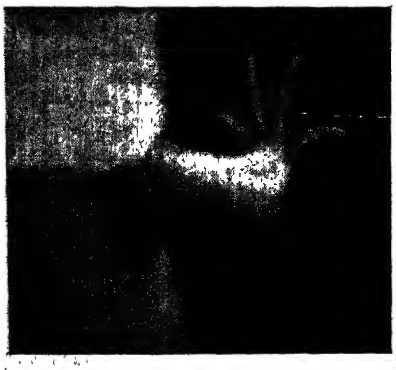

Fig. 2

but additional extremities developed only in 60 per cent of cases. According to Silaev, the first hydrolysate showed an $\frac{NH_2}{N}$ ratio amounting to 48·55 per cent, while the second hydrolysate showed 33·69 per cent. The hydrolysates gave a positive biuretic reaction; they therefore contained a mixture of polypeptides, beginning with tripeptides. Besides these experiments, the author obtained, together with V. E. Sokolova, the development of additional formations upon the insertion of enzymatic (catepsin and trypsin) hydrolysates of axolotl cartilage, but the percentage and developmental stage of the new formations was lower than in the experiments with acid hydrolysates.

Needham explains[10] the effect of organisers and inductors in embryos by biologically active substances, of the type of sterines, sex hormones and synthetic carcinogenous substances. Biologically active substances of other origin, in my opinion decomposition products of proteins, apparently play a part in the morphogenesis of adult animals; our experiments rather suggest the specificity of the action of these substances. However, we have only approached the problem of the nature of the substances causing morphogenesis in animals, and further investigations are needed. First, the active fractions of these hydrolysates must be isolated; secondly, the substances themselves; thirdly, their biological value must be tested.

Our experiments confirm the important part played by chemical substances in the morphogenesis of animals and the highly successful formulation by Nassonov of the problem of morphogenesis in adult animals.

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SOCIAL RESEARCH AND ITS ORGANISATION

By Prof. P. SARGANT FLORENCE

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THE report of the Clapham Committee[1] just issued has brought to a head several controversies about the promotion, financing and organisation of research in the social sciences. This committee on "the Provision for Social and Economic Research", of which the late Sir John Clapham was chairman, was appointed by the Lord President of the Council and the Chancellor of the Exchequer in the Coalition government and consisted in leading social scientists, economists and economic historians. But they cannot be accused of overstating the case for developing their own sciences on a scale bearing comparison

with the development of the natural sciences. Just before the Second World War, as the Committee shows, there was virtually no comparison at all. In 1938–9 universities other than Oxford and Cambridge spent £987,000 on pure science, £886,000 on medicine and £116,000 on the social sciences, and probably a much lower proportion of these sums went into research in the case of the social than the natural sciences.

Two arguments are usually put forward in the course of the controversy to justify this disparity. The first argument is that the methods of the natural sciences are more expensive, that laboratories, laboratory staff and equipment run away with money which endows the natural sciences, while the social scientist only needs paper, pens and ink, an armchair and, no doubt, a waste paper basket.

Such a contrast assumes that social science is still confined to armchair thinking and neglects the rapid development of observational and inductive methods in the social sciences largely based on the use of statistical data and measurements. These methods require libraries of source material, statistical clerks, sorters, computing machines, files and office space. If the source material is not ready to hand in censuses and other documents, the collection of data requires, as well, companies of workers observing in the field and a staff of supervisors. This field army was probably the main expense in the outlay for the "New Survey of London Life and Labour" which the Committee quote at a total of £22,000.

The controversy may then fall back on a more fundamental position. Such inductive social inquiries, it is argued, are not worth the money spent. Here the Committee replies with a telling instance. With the national income running at its present rate they point out that "the discovery of knowledge which made possible the reduction of the average of unemployment by as little as half of one per cent would mean a gain of at least £40,000,000 per annum". An industrial location survey which suggested suitable industries to overcome certain local factors in unemployment might thus pay its way handsomely. Indeed it is by no means certain that the additional outlay of £250,000 to £300,000 which the Committee now recommends to be spent on the social sciences at the universities might not pay considerably better dividends in human welfare than the same additional outlay spent on the natural sciences. In some lines of natural research there may, to put it mildly, have been—and may yet be—losses in welfare rather than profits.

Granted the Clapham Committee's case for heavy additional financial help to social research, what of the organisation of this help and its allocation between research bodies? Broadly speaking, three types of organisation for social research exist at present: government machinery; university departments; and *ad hoc* bodies usually privately endowed such as P.E.P. or the West Midland Group on Post-War Reconstruction and Planning. The encouragement each type receives should largely depend on six counts, assuming that with financial encouragement each type can secure able research workers with plenty of equipment and staff.

1. Freedom of the research workers from routine, day-to-day or emergency calls for information, decisions on policy, etc.

2. Freedom to initiate new methods and explore new fields, that is, to adopt a 'pioneer approach'.

3. Combination of research with a limited amount of teaching so as to hand on knowledge and methods widely.

4. Practical applicability and usefulness of the research undertaken.

5. Criticism from outside of the conclusions, and of the research methods by which they were reached.

6. Co-ordination between the social sciences and between the social and the natural sciences.

Among these six counts government research has an obvious advantage over university research probably only on count 4. On count 3, which the Clapham Committee is at pains to stress, the university is unique; and on count 2 has in the past been preeminent. On count 1 the experience of research sections attached to government departments is fairly damning. On counts 5 and 6 it is the *ad hoc* body that has in my experience proved itself worth considering. Indeed, granting the Clapham Committee's plan for developing the university as an organ of social research, the problems of subjection to criticism and co-ordination appear the thorniest in the path: problems for which the British Association Committee for Scientific Research on Human Institutions, reporting in June 1943, tried to find solutions[2]. Inductive methods are at present so little used in the social sciences that these thickets do not appear to obstruct—there are too few persons engaged to make the paths, let alone the roads, of co-ordination or criticism worth building. The present overall paucity of social research workers is a valid point made by the Clapham Committee. But if large sums are to be disbursed in the future, these problems of criticism and co-ordination must be foreseen and plans laid in good time.

Criticism is easier to provide for than co-ordination. The British Association Committee itself criticizes the presentation of "the main sources or possible sources of facts", namely, the official censuses and returns which its report lists in detail; and the report headlines *the need for advice on the preparation of official social statistics*. The Clapham Committee also realized the need that government departments "should be in continuous contact with outside experts" as well as in contact with one another and considers that both needs could be met by an interdepartmental committee with outside experts as members. And perhaps contact with government may make academic experts, on count 4, more practical minded.

But more is wanted. In the natural sciences the main source of original-cum-critical discussion lies in a variety of voluntary specialist societies who publish journals. "They create", to quote the British Association Committee, "a standard of excellence by which others can judge who are foremost in original work." Criticism is particularly important in connexion with any pioneer approach, and the counts listed as 2 and 5 should go hand-in-hand. Variety in approach must be safeguarded and one single school must not prevail by voting down funds for, or candidates from, schools of different approach. Such a situation has come dangerously near Britain in the shape of the quasi-monopoly held by the deductive theoretical methods of Economics and Political Science in her Universities; and the British Association Committee proposed a Society for *Factual Social Research* to present its own line of criticism as well as pioneer contributions.

Plans for co-ordinating social research are still more difficult to lay than plans for mutual criticism if

co-ordination is not to *over*lay new lines of research and criticism of the old lines. The constitution of the Council for the Social Sciences which the British Association Committee envisaged was thought out precisely to avoid the 'representatives' of existing institutions of one type overlaying any promising baby. In particular, new social sciences should be growing up and pioneering in the marginal ground between recognized orthodox disciplines such as economics and political science and also in the wide desert (or is it a jungle ?) between the natural and the social sciences.

An argument that the Clapham Committee might have, but did not, use to appeal to the more hard-headed natural scientists is that social sciences, such as social biology and industrial psychology, assume the same material basis of human inheritance as the biological natural sciences, and indeed that there is no hard and fast line dividing natural from social phenomena. As the British Association Committee pointed out, the line at present drawn by the Royal Society in its admission to fellowship splits anthropology and psychology into two. *Physical* anthropologists and *experimental* psychologists have been recognized as scientists, but not their social colleagues. Such a dichotomy may not be as unworkable as the Potsdam zoning, but it is scarcely 'natural'. The natural sciences not only grade, without natural frontier, into the social sciences, but through their technical applications impinge on society and profoundly change the practical problems to be studied by social science. The atom bomb has straightway given political science the pretty but urgent problem of the 50 per cent vote, the 66 per cent vote, the veto, etc., in deciding United Nations policy. This impact was recognized in the founding of the British Association Division on the Social and International Relations of Science; and it must be recognized in all future organisation and financing of the social sciences.

Accordingly, for the purpose of achieving a co-ordination of social and natural sciences (together with criticism, but not restriction, of pioneer work, for example, by vested interests), the British Association Committee suggested a Council to disburse research funds, to advise the Government and to co-ordinate, which would mix representatives of existing (and possibly vested) interests such as university departments and research-endowing institutes, with members less likely to be chosen as 'regular guys' (for example, by the social science sections of the British Association); and which would mix social with natural scientists chosen, for example, by the Royal Society.

Admittedly this is a long-term programme against the day when there are more social scientists. Until then it is probably wiser to have no co-ordinating body than a possibly restrictive body, and the Clapham Committee's proposal to leave the financing of social research at the university to the existing University Grants Committee may be welcome, even though its membership is rather short on the social science side. It is now up to the universities to put forward plans adequate to the additional funds likely to be offered them. The Clapham Committee has given them a sympathetic consideration, and a wise lead.

[1] Privy Council Office: Treasury. Report of the Committee on the Provision for Social and Economic Research. (Cmd. 6868.) Pp. 16. (London: H.M. Stationery Office, 1946.) 3*d*. net.

[2] Committee's Report on Scientific Research on Human Institutions, *The Advancement of Science*, Aug. 1943 (British Association); *Nature*, 152, 669 (1943).

OBITUARIES

Dr. Otto May

Dr. Otto May, whose unexpected death took place on August 15, was chairman of the British Social Hygiene Council and, before his retirement, principal medical officer of the Prudential Assurance Company.

His career was varied and distinguished. He took a first in both parts of the Natural Sciences Tripos at Cambridge. Later, at University College Hospital, London, he won the Atchison Scholarship, the Lisbon Medal, a Beit Research Fellowship and the British Medical Association Research Scholarship. He also worked at the University College Hospital, Great Ormond Street Children's Hospital, the West End Hospital for Nervous Diseases, and the Evelina Hospital for Children.

Dr. May's association with the Council dates from its earliest days, and he became joint honorary secretary of the National Council for Combating Venereal Diseases in December 1914. He lectured indefatigably on venereal disease to the troops during the First World War. It was largely due to his efforts that insured patients suffering from venereal disease received sickness benefits, from which they had previously been debarred. His work for merchant seamen was notable: he attended the meeting of the International Labour Office of the League of Nations at Geneva in 1920, which resulted in the Brussels Agreement in 1924. This was followed by the Seamen's Welfare in Ports Recommendations in 1933, and finally the Ministry of Labour set up a special Departmental Committee on Port Welfare at the beginning of the Second World War.

In 1925 the National Council for Combating Venereal Diseases changed its name to the British Social Hygiene Council, and in 1938 Dr. May became chairman of the Executive Committee—a position he held until his death. His great gifts were used unsparingly on behalf of the work of the Council; in committee he was able to grasp the outstanding points raised and to place them in their right perspective; exaggeration and muddled thinking were always anathema to him. His balanced judgment and wise counsel will be sadly missed.

One of the last pieces of work he undertook was to write a brief history of the Council which he served so faithfully.

Eleanor French

Prof. E. C. Bingham

No. 1, volume 17, of the *Rheology Bulletin* (May 1946) bears the title of "E. C. Bingham Memorial Edition", and contains tributes to the memory of Prof. Eugene Cook Bingham from the American Institute of Physics, the American Chemical Society, the American Society of Testing Materials, the National Bureau of Standards, and Lafayette College, Easton, Pennsylvania, at which he held the chair of chemistry for the past twenty-nine years. Prof. Bingham graduated from Middleburg College, Vermont, and the Johns Hopkins University. He was professor of chemistry at Richmond College, Virginia, from 1906 to 1915; then, for a time during World War I, an assistant physicist at the National Bureau of Standards, where his work led to an outstanding paper entitled "An Investigation of the Laws of Plastic Flow". In 1916 he was appointed to the

chair of chemistry at Lafayette, which position he held until his death in November last.

Bingham's first discussion on viscosity and fluidity was published in 1906, and he made this subject his life's work. His main contributions to science were in this field of flow processes, on the definition of fundamental properties, on the precise measurement of viscosity, fluidity, plasticity and related characteristics, and on the design of instruments for precision measurements of plastic flow. The original type of plastometer, devised by Bingham, is still in use, with slight modifications, in many laboratories to-day. We are indebted to Bingham for a clear and concise statement of our knowledge of flow phenomena, and for building this knowledge into a coherent science, to which he gave the name, now universally used, of 'rheology'. It was Bingham, also, who introduced the term 'poise' as the basic unit of viscosity, and whose persistent interest and encouragement resulted in the investigation by the National Bureau of Standards of the absolute value of the viscosity of water. (See J. R. Coe and T. B. Godfrey, *J. App. Phys.*, **15**, 625; May 1944.)

More than a hundred original papers on rheological subjects were published by Bingham and his associates during the past thirty years, but Bingham's interests were not, by any means, confined solely to this particular field. Physiology, chemical education, inorganic chemistry, mensuration, and even the illumination of roads and highways owe much to Bingham's interest and suggestions for improvement.

The tributes in this memorial edition from the American scientific societies bear adequate testimony to the high esteem in which Prof. Bingham was held as a man of science, to his capabilities as a lecturer and chairman of committees, to his technical skill, to his pleasant personality and friendly spirit, and to his indefatigable enthusiasm and work on behalf of the Society of Rheology, which he formed, and on behalf of the other professional bodies of which he was an active member.

We regret to announce the following deaths:

Prof. Ulric Dahlgren, professor emeritus of biology in Princeton University, on May 20, aged sixty-five.

Mr. H. E. Mitton, an authority on mining research, on September 7, aged seventy-five.

Dr. W. Payman, of the Safety in Mines Research Board, on August 12.

NEWS and VIEWS

New Air Speed Record

A new speed record of 616 m.p.h. was set up by Group Captain E. M. Donaldson, leader of the R.A.F. High-Speed Flight on September 8. The aircraft was a Gloster 'Meteor', jet propelled, with Rolls Royce 'Derwent' internal combustion turbine engines. The actual course was a three-kilometre one as laid down by the F.A.I. international regulations, off the Sussex coast between Rustington and Kingston Gorse. The R.A.F. High-Speed Flight is stationed at Tangmere, near Chichester, and has been waiting for some time past for suitable weather. The principal requirement is a high temperature, in order to reduce the retarding compressibility, and had the air been as warm as might have been expected at this season a much higher speed could have been reached. The speed is taken by regulation as the average of four runs over the course, two in each direction. The recorded speeds were 623, 610, 623 and 609 m.p.h., which beats the previous record made by Group Captain H. J. Wilson, on an earlier design of 'Meteor', by 10 m.p.h. The machine appeared to be under perfect control in spite of the bumpy air conditions and a stiff breeze blowing across the course. This is a tribute to both the skill of the pilot and the accuracy of the design, as when flying near the sonic speeds the aircraft is susceptible to changes in compressibility effects that set up a see-saw track which not only reduces the overall speed over the course, but is also dangerous to the structure of the machine.

It is disappointing that a speed of 1,000 kilometres an hour (621·3 m.p.h.) was not reached, as it was felt that this round figure would have sounded more impressive in countries that use the metric system. The air temperature was about 69° F. during the runs. Had it been more than 75° F.—a not unfair expectation at this time of the year—a speed of about 630 m.p.h. could probably have been attained. Records of this kind are made on machines specially designed for maximum speed, and carefully maintained and nursed for the attempt. It is nevertheless interesting to note that the impact of this development on ordinary everyday flying has raised the speeds of this considerably. Squadron Leader Cotes-Preedy flew a 'Meteor Mark IV', similar to the standard R.A.F. high-speed fighter, from Paris to Geneva on September 9 at an average speed of 510 m.p.h. This machine has been purchased by the Swiss military authorities as part of the equipment of a high-speed development flight in that country.

American Chemical Society Awards: Priestley Medal

The Priestley Medal, the highest honour in American chemistry, has been awarded to Prof. Roger Adams, head of the department of chemistry in the University of Illinois and one of the nation's leading organic chemists. The Priestley Medal, named after the discoverer of oxygen, is the fourth high scientific honour won by Prof. Adams within the past year. While he was serving with General L. D. Clay (deputy military governor of the American Occupation Zone in Germany), he received the Davy Medal of the Royal Society of London in recognition of his extensive researches in the field of organic chemistry. After he returned to the United States, he was awarded the Theodore William Richards Medal of the American Chemical Society's North-eastern Section for conspicuous achievement in organic chemistry. Later he was selected to give the first Remsen Memorial Lecture at the Johns Hopkins University in Baltimore, inaugurating an annual series founded by the Maryland Section of the Society in honour of the late Ira Remsen, pioneer in American organic chemistry. Prof. Adams, who was president of the American Chemical Society in 1935, also holds the Willard Gibbs Medal of the Society's Chicago Section, granted in 1936 for his work in synthetic organic chemistry and his achievements as a teacher, and the William H. Nichols Medal of the New York Section, conferred in 1927 for distinguished contributions to original research.

Born in Boston on January 2, 1889, Prof. Adams is a graduate of Harvard University, where he received the A.B. degree in 1909, the A.M. in 1910 and the Ph.D. in 1912. He later received the honorary degree of Doctor of Science from the Polytechnic Institute of Brooklyn, North-western University and the University of Rochester. He went abroad to study at the University of Berlin and at the Kaiser Wilhelm Institute during 1912–13. From 1913 to 1915 he was an instructor in organic chemistry at Harvard and at Radcliffe College. He joined the faculty of the University of Illinois as assistant professor in 1916, becoming a professor in 1919 and head of the chemistry department in 1926. He was a member of President Roosevelt's Science Advisory Board in 1934–35, and in World War II he served in Washington with the National Defense Research Committee. Prof. Adams is a fellow of the American Association for the Advancement of Science and was chairman of Section C of the Association in 1927. He is a member of the American Academy of Arts and Sciences and the American Philosophical Society, and an honorary fellow of the Chemical Society of London. He has been a member of the Council and chairman of the Chemistry Section of the National Academy of Sciences, and a member of the fellowship board of the National Research Council. Besides serving the American Chemical Society as president and chairman of the Board of Directors, he was a director during 1931–36 and 1940–43, and a councillor-at-large during 1923–29.

Eli Lilly and Company Prize

Dr. John D. Ferry, assistant professor of chemistry in the University of Wisconsin, who developed valuable surgical products from blood plasma during the War, has been given the Eli Lilly and Company Prize of 1,000 dollars awarded by the American Chemical Society for "versatile and incisive studies on the chemistry, especially the physical chemistry, of large molecules". Besides doing war-time research on blood plasma in the Department of Physical Chemistry at the Harvard Medical School, Dr. Ferry served on a special advisory panel of the Army Quartermaster Corps on the preparation and use of plastics and films from high polymers. Dr. Ferry was born at Dawson, British Columbia, on May 4, 1912, and graduated from Stanford University; during 1932–34 he worked at the National Institute for Medical Research in London. His early work was upon the size of viruses as estimated by their passage through membranes. Studies of polyisobutylene and polystyrene and of rubber followed, leading to an interest into the properties of large protein molecules and of the mechanical properties of their gels. A photo-elastic method for the study of elasticity and rigidity of gels over a wide range of frequencies has contributed greatly to our understanding on one hand of such systems as polystyrene-xylene; on the other, of the gelation of gelatin and the clotting of blood. His knowledge of proteins in the solid state has led during the War to the production, from the proteins concerned with the natural clotting process, of fibrinogen plastic and fibrin tubes and films. Fibrin film has found acceptance in neuro-surgery as a dural substitute and is now being applied to other surgical uses. Prepared entirely from fractions of human plasma, these products approach those that occur in Nature in their physical properties, in that they do not lead to foreign body reactions, and in their ultimate fate in the body.

Prof. P. van Oye

Prof. Dr. P. van Oye, the leading Belgian hydrobiologist, was sixty on August 24, an event which has been duly celebrated by his numerous friends and followers; other festivities, of a more official character, are to follow shortly. Prof. van Oye can look back on more than thirty years of splendid biological work, including for a great part studies on plankton of many countries, in most cases the result of personal exhaustive and exhausting field-work; in this last respect, he most certainly can compete with the keenest of his younger followers. He wrote numerous and important papers on Desmids (on which he is one of the world's leading authorities), Rotators, Rhizopods, etc.; he is the discoverer of the periodical evolution of the plankton in tropical regions, and, together with Apsteins, of the rule on the variation of plankton-facies. Another very important discovery of his is the constancy of the *p*H in a given aquatic biotope. Prof. van Oye spent several years in Indonesia and the Belgian Congo, and shortly before the War visited Iceland. The Biogeographical Institute, University of Ghent, has done and is doing useful work under his leadership. The patriotic attitude of Prof. van Oye under the occupation caused the Germans to relieve him of his post and even to imprison him for some weeks.

New European Scientific Periodicals

The revival of scientific thought in Europe has been signalled by the reappearance of familiar journals which were suppressed during the German occupation, and by the publication of new journals. *La Nature* and *Revue générale des sciences* in France were swift to recover, and they were joined a few months ago by the new journal *Atomes*. A little more than a year ago, *Experientia*, described as a "monthly journal of pure and applied science", under the direction of A. v. Muralt, L. Ruzicka and J. Weigle, with Dr. H. Mislin as editor, was published by Verlag Birkhäuser AG. of Basle. The general language used is German; but announcements are printed in German, French, Italian and English. The contents consist of general illustrated articles (in one of the languages mentioned), followed by "brief reports" of current work corresponding to the "Letters to the Editors" in *Nature*, most of which have summaries in a language other than that of the 'report' itself, and book reviews, etc. The published price is 2 Swiss francs each issue plus postage. From Germany comes *Zeitschrift für Naturforschung*, published by Dieterich'she Verlagsbuchhandlung, Wiesbaden, by authority of the Military Government. This appeared in January of this year, under the direction of A. Sommerfeld, K. Clusius and A. Kühn, and is also a monthly journal. It contains short original articles, preliminary announcements of investigations, reviews of recent work, and news; the whole is in German.

Freedom of Intellectual Liberty

In our age the idea of intellectual liberty is under attack from two directions. On one hand, there are its theoretical enemies, the apologists of totalitarianism; and on the other, its immediate practical enemies, monopoly and bureaucracy ("The Prevention of Literature." By George Orwell. (Polemic No. 2.) London: Rodney Phillips and Co., 1946. 2*s*. 6*d*.). The independence of the writer and the artist are being eaten away by vague economic forces and also

undermined by those who should be its defenders. Underlying the attacks on freedom of thought and of the Press is the dangerous proposition that freedom is undesirable and that intellectual honesty is a form of anti-social selfishness. The enemies of intellectual liberty try to present their case as a plea for discipline versus individualism, leaving in the background that the issue is truth versus untruth. Totalitarianism, whether political or religious, exerts its greatest pressure on the intellectual at the point where literature and politics cross. The exact sciences are not, so far, menaced to the same extent, yet some scientific workers seem to think that the destruction of liberty is of no importance so long as their own line of work is unaffected. Even totalitarian States tolerate the scientific worker for the moment because his work is recognized by the rulers as necessary, if only to prepare for war. But when the totalitarian State will be well established, this may not be so. If, therefore, the man of science would guard the integrity of science, he should develop some kind of solidarity with his literary colleagues. In Great Britain, broadly speaking, there is liberty; but there is the sinister suggestion that the conscious enemies of liberty are those to whom liberty ought to mean much.

R.C.A. Review

All those concerned with radio research and development will welcome the reappearance, after a four-year interval, of the *R.C.A. Review*, a technical journal recording progress in radio and electronics research and engineering as described by scientific workers, engineers and executives of the Radio Corporation of America. The March 1946 issue forms the first number of volume 7; and in an introduction thereto General David Sarnoff, president of the Radio Corporation of America, explains that the new *R.C.A. Review* is written by men of science and engineers not only to relate their past achievements but also to reflect the thoughts of those whose pioneering in research, development and engineering are projecting the present into the future. The eight papers in the present issue cover a variety of subjects relating to television, navigation and radio telegraphic signalling by change of frequency in contrast with on-off keying. The experimental results obtained in the development of omni-directional radio beacons for aerial navigation are described in a paper by D. G. C. Luck, of which the first two parts were published in 1941 and 1942. Another paper, by I. F. Byrnes, discusses the possibilities of a shipboard radar installation as an aid to navigation for the mercantile marine. The development of the image orthicon tube for an extremely sensitive television camera is described by R. D. Kell and G. C. Szikali of the Research Dept., R.C.A. Laboratories; while some of the results obtainable by the use of this camera for field television operation are dealt with by R. E. Shelby and H. P. Lee, of the National Broadcasting Company, Inc. Short biographical notes with photographs of all the contributors form an interesting appendix to this publication.

New Units for the Measurement of Radioactivity

Two new units, the 'rutherford' and the 'roentgen-per-hour at one metre' for the measurement of radioactivity, have recently been recommended by the National Bureau of Standards, at the suggestion of the Committee on Radioactivity of the National Research Council. The Radiology Congress in Brussels in 1910 defined the curie as "the amount of radon in equilibrium with one gram of radium". Therefore, strictly speaking, the curie can only be used to represent the disintegration-rate of radium or its equilibrium products. As is pointed out by E. U. Condon and L. F. Curtiss (*Rev. Sci. Instr.*, 17, 249; June 1946. Also *Phys. Rev.*, 69, 672; June 1946), it has, however, become the custom to use the curie, quite erroneously, as the unit of strength of all radioactive sources. The disintegration-rate, which correctly specifies the strength of a radioactive source, is a pure number, and is determined by the decay constant and the number of atoms of the radioactive isotope in the source. All that is required, therefore, to establish a proper unit, is to choose a suitable number, preferably a multiple of ten. The number 10^6, with the name 'rutherford', abbreviated to 'rd.', is recommended. No confusion can arise when dealing with the radium family, as the curie and rutherford are sufficiently different in magnitude. Apart from that of definition, the rutherford has other advantages over the curie. The rutherford is a definite unit, whereas the curie is uncertain to at least 4 per cent, and also, the new unit does away with the necessity for measuring radio-isotopes in terms of a standard. For the intensity of gamma-ray sources, it is recommended that a roentgen-per-hour at one metre be used in place of the curie. The abbreviation, 'r.h.m.', pronounced 'rum', is suggested. A gamma-ray source of one r.h.m. has a gamma-ray strength of the same order of magnitude as that of one curie of radium.

A Thermal Eyepiece for the Telescope

An article with this title by H. P. Wilkins, an assiduous observer of the moon, who recently produced a 300-in. lunar map appears in *Sky and Telescope* of May. Mr. Wilkins has made a 'thermal eyepiece' which enables the heat of the moon to be noted visually when it is inserted in the focus of his 12½-in. Newtonian reflector. The instrument consists of a very small light couple suspended between the poles of a permanent magnet, one junction of the couple being at the focus of a positive eyepiece of orthoscopic or monocentric type. It is necessary to suspend the couple freely, and hence in the case of an equatorial mounting the tube or eyepiece should rotate. The apparatus is enclosed in a brass case which fits into the sliding eyepiece tube like an ordinary eyepiece. The couple is made from strips of copper and constantan, and the suspension is a very fine quartz thread. Full directions are given about the use of the instrument, the principle of which depends upon the fact that the thermo-electric current produced by the heat of the moon causes the loop to turn in the field of the permanent magnet, and it is possible to judge the relative intensities of radiation from various portions of the lunar surface. The apparatus can be shielded from the heat of the body by interposing a non-conducting sheet of wood or asbestos. Interesting results have been obtained during lunar eclipses, the turning moment of the couple diminishing before the encroachment of the umbra and being reduced to zero during totality. During penumbral eclipses, when the sun, as seen from the moon, appears partially eclipsed by the earth, a diminution of the heat from the moon is noticed. It seems possible for most amateurs with a small mechanical equipment to construct one of these instruments, though many details must be attended to; these are dealt with very fully in the article.

Industrial Reconstruction in Italy

ANTONIO REVESSI has an article on this subject in *Ricerca Scientifica e Ricostruzione* (Rome), December 1945, which deals with some of the chief points essential to the reconstruction of industries in Italy after the evils which have followed the Fascist regime. A comparison of the industrial life in other countries—in particular in Switzerland—with that of Italy shows the inherent weakness in the system of the latter. The necessity of scientific-experimental research applied to industrial reconstruction is urgent if the maximum efficiency and output are to be realized, and there must be collaboration between the technical expert and the manufacturer. Although there may be various objections on the grounds of expense, difficulty of training technicians, etc., Revessi waives these aside, and advocates a slow but sure development, never losing sight of the ultimate goal, which is vital if Italy is to recover her position—the export of her products. There must be no delusions about an immediate recovery of the export trade which Italy enjoyed before the Fascists destroyed it; nevertheless, by rationalization of industry and by proper organisation, it is possible for her to secure a high position in the industrial world.

Astronomical Observations in Spain

THE greater portion of the Bulletin issued by the Observatory of Madrid (*Bol. Ast. Observ. Madrid*, 3, No. 4; 1946) is taken up with statistics relating to sunspots seen from the Observatories of Madrid, Valencia and also Cartuja (Granada), and a résumé of the results is given on pp. 18–25. Much interesting information is provided on the observations of Mars during the 1941 opposition, the work being carried out with the 41-cm. Grubb equatorial, focal length 5 metres, which was specially suitable for this type of work. This portion is illustrated by diagrams and also by a number of photographs of the planet taken between September 15 and November 1, 1941. The results of the occultations of thirty stars observed by M. Martín Lorón in 1945 are also reported.

Archæology in Africa

MR. THURSTON SHAW, until recently an officer in the Gold Coast Educational Service, has written a very useful article (Mem. xxi, International African Institute. Oxford Univ. Press. 2*s*. net) on the study of Africa's past. The idea of the article is to help the average person in Africa who has had no special training in archæology to know what to look for and what to do, so that useful information can be obtained. Of its kind the work is one of the most serviceable that has been produced.

Leicester Museum's Schools Service

OF the departmental reports in the forty-first annual report (April 1, 1944–March 31, 1945) recently issued by the Leicester City Museum and Art Gallery, that of the Schools Service is of particular and general interest. During the period under review, classes were instructed in the main museum as well as in the branch museums; special visits were arranged for blind and deaf children, and the loan collections (which include museum specimens, models, dioramas, charts, etc., covering most school subjects) were extended to evacuated schools. Army units in the area made use of the same collections in the development of Forces educational schemes, and a collection of picture reproductions was extensively used in courses on the appreciation of art. In conjunction with Dr. Boley, of the Psychology Department of the Leicester Education Committee, two members of the staff instructed special classes in the use and construction of puppets for puppet shows. The children themselves took part in these proceedings, but the exact intent of, or the conclusions drawn from, the results of these activities are not reported. The Museum school service at Leicester has been active and progressive for many years and most, if not all, subsequent and similar schemes elsewhere have been based upon it. That the Leicester methods and results are of interest to outside educational institutions and other bodies is shown by the reference to visitors from London, Nottingham, Glasgow, and the research department of the National Association of Local Government Officers. Further, inspectors from the Board of Education went to observe them, and this fact, especially, points to the possibility of future developments in this work, not only in Leicester, but also wherever suitable museum collections exist.

Announcements

DR. T. F. DIXON has been appointed professor of biochemistry in the Royal Medical College, Baghdad.

As from November 1, Dr. N. Hamilton Fairley, who takes up his appointment as Wellcome professor of tropical medicine in the University of London, will cease to be director of the Wellcome Laboratories of Tropical Medicine, but will become consultant in tropical medicine to the Wellcome Foundation. Brigadier John S. K. Boyd, at present director of pathology, War Office, will become director of the Wellcome Laboratories of Tropical Medicine.

MISS MARION GOSSET, chief cataloguer at the Science Library, South Kensington, has been appointed librarian of the Atomic Energy Research Establishment at Harwell, near Didcot. Miss Gosset takes up her new appointment on September 18.

THE following appointments, promotions and transfers in the Colonial Services have recently been made: M. A. Blane, to be agricultural officer, Gold Coast; J. A. R. Maclean, to be chemist, West Africa Cocoa Research Institute, Gold Coast; G. Paton, to be agricultural officer, Nyasaland; G. B. Rattray, to be agricultural officer, Kenya; R. B. Reid, to be agricultural officer, Northern Rhodesia; E. A. Anderson, to be assistant conservator of forests, Gold Coast; S. J. Mayne, to be geologist, Tanganyika; P. R. Wilkinson, to be entomologist (tsetse), Uganda; W. E. Freeman (botanist, Nigeria), to be senior botanist, Nigeria; E. J. Gregory (agricultural officer, Uganda), to be senior agricultural officer, Uganda; R. H. Le Pelley (entomologist, Kenya), to be senior entomologist, Kenya; T. T. Brand (senior assistant conservator of forests, Nigeria), to be conservator of forests, Nigeria; G. S. Cansdale (assistant conservator of forests, Gold Coast), to be senior assistant conservator of forests, Gold Coast; A. J. Cox (senior assistant conservator of forests, Gold Coast), to be conservator of forests, Gold Coast; F. G. Harper (assistant conservator of forests, Gold Coast), to be senior assistant conservator of forests, Gold Coast; D. Kinloch (assistant conservator of forests, Gold Coast), to be senior assistant conservator of forests, Gold Coast.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Specific Inhibition of Esterase in Ester-Hydrolysing Enzyme Systems

In trying out several emulsifying agents having at a fairly neutral *p*H a stabilizing effect upon emulsions of olive oil, monobutyrine, ethylbutyrate, methylbutyrate and ethylpropionate, the following observations were made. Gummi arabicum activates on one hand the cleavage of olive oil to a very remarkable degree, but exerts no influence upon the cleavage of monobutyrine. It causes on the other hand a very sharp inhibition of the saponification of such esters where glycerol is substituted by lower alcohols. This inhibitory effect amounted in several instances (depending upon the source of the lypolytic enzymes employed) to 100 per cent, and in no case was finally less than 65 per cent. In the tests with olive oil, the activating effect of gummi arabicum proved to be dependent upon the stability of the emulsion, which on its part depends principally upon the procedure of preparation and to a much less degree upon the absolute amount of gummi arabicum added. Thus, in several instances, where no stable emulsions were obtained, the activating effect was either nil or very small.

The concentration of the substrates employed in the enzyme tests (see above) was in all cases 0·001 moles, while the concentration of olive oil was adjusted, according to its saponification value, to contain the same amount of saponifiable linkages. The amount of gummi arabicum added was in all cases half the amount by weight of the substrates (commercial gummi arabicum was employed).

The enzymes used were the glycerol extracts from pancreatin (Parke, Davis and Co.), glycerol extracts from worker maggots of the honey bee of different ages, from organs of adult worker bees, and beef liver juice obtained in the usual way with the hydraulic press.

To illustrate the results obtained, some examples are given in the accompanying tables. Concentration of substrate: 1 millimole contained in 10 ml. phosphate-buffer 7·2 (Sörensen). The extracts of the enzymes were prepared by grinding the biological materials with 90 per cent glycerol in a mortar (10 gm. glycerol per 1 gm. of substance) and leaving them overnight at 30° C. The undissolved part was then centrifuged off and the extract diluted with buffer solution *p*H 7·2 (Sörensen) as described below. Values of additional cleavage are corrected by the blanks and given in ml. of *n*/20 NaOH (Sörensen's formol titration). All tests were carried out at 37° C.

Table 1. Enzyme: 0·5 beef liver juice 1 : 5 (diluted with buffer solution) added to 20·5 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 4 ml. solution with gummi arabicum	without
Methylbutyrate	30 min.	0·30	0·60
	90 min.	0·45	1·25
	22 hr.	0·98	4·55
Ethylbutyrate	30 min.	0·20	0·30
	90 min.	0·35	0·65
	22 hr.	0·73	4·43
Ethylpropionate	30 min.	0·05	0·40
	90 min.	0·25	0·95
	22 hr.	1·35	4·18

Table 2. Enzyme: 3 ml. glycerol extract from worker maggots of the honey bee, 5 days of age, 3 : 2 (diluted with buffer solution) added to 10 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 5 ml. of solution with gummi arabicum	without
Methylbutyrate	23 hr.	0·50	2·15
Ethylbutyrate	„	0·25	4·35
Ethylpropionate	„	0·15	2·10

Table 3. Enzyme: 3 ml. glycerol extract from worker maggots of the honey bee, 8 days of age. 3 : 2 (diluted with buffer solution) added to 10 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 5 ml. solution with gummi arabicum	without
Methylbutyrate	23 hr.	0·05	1·40

Table 4. Enzyme: 3 ml. glycerol extract from pancreatin 1 : 2 (diluted with buffer solution) added to 10 ml. of substrate solution

Substrate	Time of action	Additional cleavage in 5 ml. solution with gummi arabicum	without
Methylbutyrate	23 hr.	2·10	7·40
Ethylbutyrate	23 „	0·85	8·00
Monobutyrine	22 „	3·40	3·35
Olive oil	22 „	1·75	0·85

It thus appears that there are at least two distinctly different enzymes (or enzyme systems) present in these glycerol extracts: (1) a lipase, hydrolysing esters of glycerol, which is not inhibited by gummi arabicum; and (2) an esterase, hydrolysing esters of lower alcohols than glycerol, which is inhibited by addition of gummi arabicum.

Thus, substrates such as methylbutyrate and ethylbutyrate, usually recommended as standard substrates for the measurement of the activity of pancreatic lipase, seem, *de facto*, to undergo cleavage not by the lipase itself but by an esterase associated with the latter.

Further investigation into the nature of this inhibitory effect is proceeding.

A detailed report will be given elsewhere.

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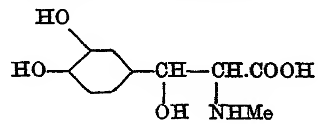
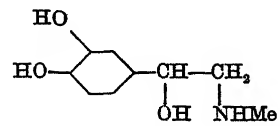
Adrenaline Carboxylic Acid (N-Methyl-β-(3 : 4-dihydroxyphenyl)-serine)

This hitherto unrecorded amino-acid (I) is of considerable pharmacological interest in view of its intermediate relationship to adrenaline (II) and to 'dopa' (III): at the suggestion of Dr. H. Blaschko, we have consequently investigated its preparation.



(I)



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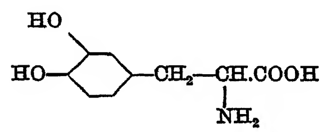
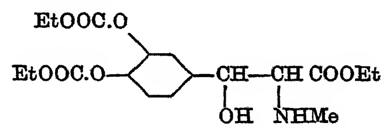


(III)



(IV)

The following synthesis has now been accomplished. Dicarbethoxyprotocatechuic aldehyde was condensed with sarcosine ethyl ester under the influence of sodium in ether[1] to give ultimately N-methyl-β-(3 : 4-dicarbethoxy-dihydroxyphenyl)-serine ethyl ester (IV). Since the hydrochloride of this compound was a viscous syrup, it was converted to the oxalate, m.p. 147° (decomp.), which on recrystallization dissociated to give the monohydrated hydrogen oxalate, m.p. 157° (decomp.). Considerable difficulty was experienced in the attempted alkaline hydrolysis of salts of (IV). Hydrolysis was, however, smoothly effected in good yield with negligible oxidation by boiling with dilute acetic acid, and the amino-acid (I), recrystallized from aqueous alcohol, formed cream-coloured crystals, m.p. 233° (decomp.) (Found: C, 53·1; H, 5·5; N, 6·1 per cent. $C_{10}H_{13}O_5N$ requires C, 52·9; H, 5·7; N, 6·2 per cent). No indication of the presence of more than one racemate was obtained.

Further work is required before the mechanism of the above condensation is elucidated, but certain interesting points have emerged. Rosenmund and Dornsaft[1] adduced evidence that the condensation of benzaldehyde with glycine ethyl ester involves the initial formation of a Schiff's base, CH_2[N:CHPh]COOEt, which then condenses with a second molecule of the aldehyde to form PhCH(OH).CH[N:CHPh]COOEt, from which the initial benzaldehyde residue is ultimately hydrolysed, giving the acid PhCH(OH).CH(NH_2)COOH. We find that our condensation does not succeed unless two molecules of aldehyde are used for each molecule of sarcosine ester. This suggests that the reaction may proceed through the stages CH_2[NMe.CH(OH)*R*]COOEt → *R*CH(OH)CH[NMe.CH(OH)*R*]COOEt → *R*CH(OH)CH(NHMe)COOEt, where *R* represents the 3 : 4-dicarbethoxy-dihydroxyphenyl group. It is noteworthy that we have been unable to condense veratric aldehyde with sarcosine ester, in spite of a wide variety of conditions employed, and the condensation appears to be critically influenced by the groups used to protect the two phenolic groups.

The examination of the amino-acid (I) is being undertaken in the Department of Pharmacology at Oxford. The description of our chemical work will appear elsewhere.

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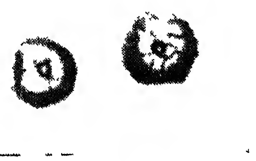
[1] Cf. Rosenmund and Dornsaft, *Ber.*, 52, 1734 (1919).

Crystallization of Arginase

ATTEMPTS to obtain arginase in a pure state were only partly successful and resulted in an approximately twenty-fold purification of the enzyme from liver extracts[1,2,3].

While engaged in research on the rôle of arginase in the metabolism of various types of malignant tissue, I attempted a purification of the enzyme from ox liver with the view of using a purified solution for metabolic experiments on malignant tumours. A high degree of purification was eventually reached, and from solutions above a certain activity of the enzyme, protein crystals were obtained, before or after dialysis, in five different cases and by different methods of precipitation. The hexagonal crystals, as shown in the accompanying reproduction, were found, however, to be too unstable to separate them from the mother liquor in order to test their activity, and even during the short time necessary for taking a microphotograph, the crystals showed signs of resolution. The shape of the crystals was found to be hexagonal whichever the method of purification.

There is a linear relation between activity and concentration of the enzyme; the purest fraction was almost colourless and showed a Q_{CO_2} of 67,000 at 37°.



(× 330.)

The use of the greater part of the purest fractions for metabolic experiments and the instability of the crystals have so far prevented further investigations of the pure enzyme. However, some information obtained during the process of purification is given below, as well as an outline of the procedure.

Activity test for enzyme fractions. 0·1–0·05 ml. of the enzyme solution is incubated for 15 minutes at 30° with 2 ml. 0·1 *M* pyrophosphate, *p*H 9·0 plus 0·2 ml. 1 per cent cobalt chloride, after which period 0·5 ml. 2 per cent *l* (+) arginine hydrochloride is added and the incubation continued for exactly 10 minutes. The enzyme action is then stopped by addition of 0·8 ml. 3 *M* acetate buffer *p*H 4·65 and the urea estimated manometrically as carbon dioxide by addition of urease. Activity is expressed as $\frac{\mu l \text{ urea} - CO_2}{\text{mgm. } N}$ in 10 minutes, which corresponds approximately to the Q value $\frac{\mu l \text{ urea} - CO_2}{\text{mgm. protein} \times \text{hour}}$.

Outline of purification. (1) Preparation of acetone powder: 880 gm. fresh ox liver are minced and treated with 5 volumes of acetone at room temperature. The suspension is filtered, the residue treated with another 2 volumes of acetone and air dried. Yield, 300 gm. The powder, stored *in vacuo*, in the ice chest, keeps most of its activity two to three months. Activity of suspension, approximately 200.

(2) Extraction: 100 gm. acetone powder are extracted at room temperature with 2 l. *N*/500 potassium hydroxide for 100 minutes, the suspension is centrifuged, the turbid, dark-red solution (1,770 ml.) contains the enzyme (Sol. A). Activity, 300–500. With fresh acetone powder, higher activities are obtained.

(3) Heating: Sol. A, at a temperature of 25°, is adjusted to *p*H 6·1 (Brom-Cresol-Purple) and heated in 600 ml. portions with vigorous shaking to 51°; the temperature is maintained for 75 sec., the mixture cooled rapidly and the precipitate centrifuged off. The turbid supernatant fluid (1,650 ml.) is adjusted to *p*H 7·2 and contains the enzyme (Sol. B). Activity, 600–800.

(4) Acetone precipitation: To Sol. B 1·2 vol. acetone are added at +3° with vigorous shaking in 400 ml. portions. The precipitate, which contains the enzyme, is centrifuged off in cooled cups and resuspended in a third of the original volume of distilled water. The insoluble part is separated and discarded. The solution is adjusted to *p*H 6·3 (Brom-Thymol-Blue) and left standing in the ice chest until a bulky precipitate is formed, which is separated and discarded. The pink, fairly clear solution (1,650 ml.) is adjusted to *p*H 7·2 and treated with a cobalt chloride solution of 0·02 per cent final concentration (Sol. C). Activity, 1,500–2,000.

(5) Heating: Sol. C, at a temperature of 25°, is placed in a water bath at 75° and heated with vigorous stirring to 54°. The temperature is maintained for 3 minutes, the solution cooled and the bulky precipitate separated and discarded. Supernatant fluid: Sol. D (570 ml.). Activity: 4,000–6,000.

(6) Precipitation with zinc sulphate: By using a weak solution of zinc sulphate, the greater part of the coloured material can be removed. To Sol. D, zinc sulphate crystals are cautiously added until the solution becomes turbid and precipitation of coloured material begins. At this point the addition of the zinc salt is stopped. The *p*H during this procedure should be kept at 7·5–7·8, and the final concentration of zinc sulphate should not exceed 0·1 per cent. Cobalt chloride salt is added to a final concentration of 0·01 per cent to the supernatant fluid (550 ml.), the *p*H of which is adjusted to 7·2 (Sol. E). Activity, 8,000–14,000.

(7) Ammonium sulphate fractionation: Sol. E is dialysed in succession against 20 vol. ammonium sulphate solution of 50, 55, 60 and 65 per cent saturation at *p*H 7·2 for 7–10 hours at room temperature. The precipitate after each dialysis is removed, taken up in 1/10 vol. distilled water and tested for activity. The fractions showing an activity exceeding 10,000 (mainly with 50, 55 and 60 per cent saturation) are united and the dialysing procedure is repeated. In this way fractions of an activity of 20,000–50,000 are obtained. They are adjusted to *p*H 6·6 and dialysed against 44 per cent saturation; the precipitate is discarded and the supernatant fluid is finally dialysed against 47 per cent saturation, when crystallization sets it.

Stability: The enzyme is stable for 1–2 days in Sol. A and for 1–2 weeks in Sol. B. It is less stable in Sol. C and becomes somewhat unstable in Sols. D and E. The ammonium sulphate fractions are fairly stable for one month. The enzyme is most stable between *p*H 7·2 and 8·0, and least stable at *p*H below 5·5.

Activation by metal salts. The enzyme solution is activated by cobalt and nickel salts in stages A and B, but not by manganese salts, while colloidal iron inhibits the enzyme. In stages D and E activation by cobalt salts was observed, while in the purest stages (ammonium sulphate fractions) no significant activation was seen by any of the metals mentioned.

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Aug. 6.

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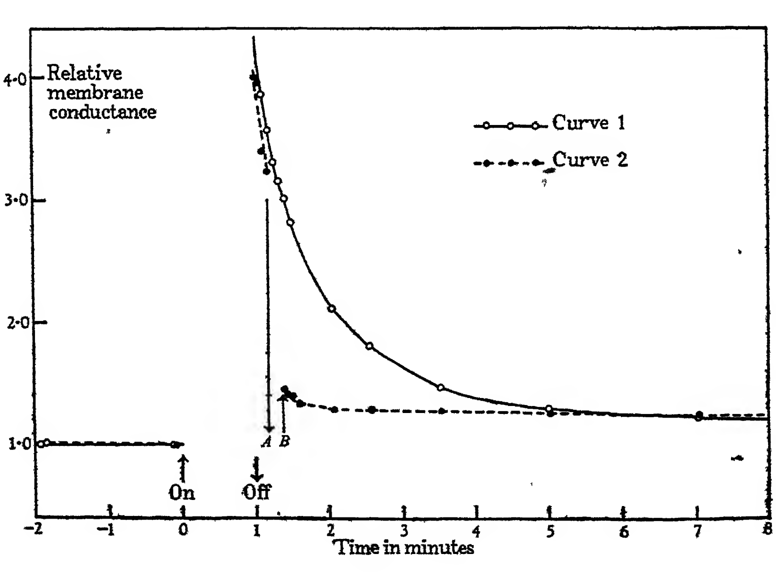
Potassium Leakage from an Active Nerve Fibre

ACCORDING to the membrane theory of nervous action, a minute quantity of potassium ions should leak out of a nerve fibre each time that an impulse travels along it. There is now general agreement that prolonged stimulation may cause a loss of potassium from nerve and muscle[1,2,3,4,5], but there is no certainty that activity is normally and invariably accompanied by such leakage. Nor is there any clear information about the time course of the leakage of potassium.

We have recently devised an indirect but very sensitive method of recording the loss of potassium from an isolated axon and have applied it to the 30 μ non-medullated axons from *Carcinus mœnas*[6]. The method depends upon a previously unpublished observation. *Carcinus* blood contains 11–12 m.mol. potassium per litre[7], and isolated *Carcinus* axons survive for 24 hours in sea-water containing 9·8 m.mol. potassium per litre. If the potassium chloride content of sea-water is increased by 20 m.mol./l., the fibres continue to transmit impulses satisfactorily, but their membrane conductance increases approximately threefold. On the other hand, addition of a similar quantity of sodium chloride produces no measurable change in membrane conductance. The difference between the effects of potassium chloride and sodium chloride is probably connected with the difference in mobility or solubility of potassium and sodium ions in the surface membrane, and provides some support for the view that this membrane is much more permeable to potassium than to sodium ions. It also provides a practical method of measuring the amount of potassium leaking from a nerve fibre.

When an isolated axon is immersed in oil, it is surrounded by a thin film of sea-water. Electrical and optical estimates give the cross-sectional area of this film as approximately 3×10^{-6} cm.^{2}. Hence if 3×10^{-11} mol. potassium were to leak out of 1 cm. length of nerve fibre, it would double the concentration of potassium in the external fluid and should produce a large increase in membrane conductance.



We have therefore studied the cumulative effects of nerve impulses upon the membrane conductance of an isolated nerve fibre immersed in oil.

A typical experiment is given in the accompanying graph, Curve 1, and shows how the membrane conductance is affected by a short burst of activity. At time 0, a train of impulses of frequency 118 per sec. was initiated by means of a thyratron stimulator. At time 1 0 min. the stimulus was switched off and the membrane conductance again measured. By the end of the active period the membrane conductance had increased fourfold, but it returned rapidly to a steady level not very different from that which existed previously. These effects could have been produced by leakage of potassium from the active axon followed by a re-absorption during the period of recovery. But they might equally well have been due to some structural alteration in the membrane which did not depend upon a chemical change in the external medium. The second possibility was excluded by the fact that the time-course of recovery could be profoundly modified by dipping the nerve fibre into a large volume of sea-water for a few seconds. The effect of this test is shown by Curve 2, which was obtained in exactly the same manner as Curve 1, except that the axon was dipped into sea-water during the period *AB*. The resulting curve shows that immersion in sea-water caused the membrane conductance to return almost immediately to a value which was close to the final recovery level of Curve 1. In our view, this experiment and others of a similar kind prove beyond reasonable doubt that activity is associated with the leakage of a substance the effect of which on the nerve membrane is very like that of potassium.

The absolute amount of potassium lost by an active axon could be calculated on the assumption that the observed changes in conductance were wholly due to an increase in the potassium content of the external fluid. Eleven determinations of this kind were made and gave an average value of $1{\cdot}7 \times 10^{-12}$ for the number of moles of potassium which leak through 1 sq. cm. of membrane in one impulse. The charge of $1{\cdot}6 \times 10^{-7}$ coulomb carried by this number of potassium ions may be compared with the charge of the resting membrane. Estimated values of $1{\cdot}3\,\mu$F cm.$^{-2}$ for the membrane capacity and 60 mV. for the resting potential give the resting charge density as $7{\cdot}8 \times 10^{-8}$ coulomb cm.$^{-2}$. The amount of potassium lost in each impulse therefore appears to be more than sufficient to discharge the membrane capacity in the manner required by the membrane theory.

During the period of recovery, potassium appeared to be re-absorbed at a rate of approximately 3×10^{-10} mol. cm.$^{-2}$ sec.$^{-1}$ when its external concentration had increased threefold. This re-absorption may be thought of as an active process of a secretory type, but it can also be satisfactorily explained in terms of the type of Donnan equilibrium proposed by Boyle and Conway[8].

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[5] Fenn, W. O., *Physiol. Rev.*, **20**, 377 (1940).
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Transformations of the Retinal Ganglionic Cells in Tissue Cultures

It is well known that axons of the retinal ganglionic cells are characterized by a strictly radial direction. They converge in the optic papilla similarly to the spokes of the wheel and make their further course by the way of the optic nerve and its chiasma.

The study of their regenerative process in tissue cultures in various vertebrates revealed a regularity which is of much interest and is obviously peculiar to the retinal ganglionic cells. The growth of regenerating axons in all organisms studied always develops in the same direction inside the explant as well as at their passage to the substratum of fibrin. It corresponds to the side along which the old axon passed. The course of the retinal axons is strictly polar. Under conditions of explantation, the growing fibres seem to push towards the exit of the optic nerve, that is, to the retinal papilla. This direction, as a rule, is maintained in all explants; in all and certainly in all vertebrate retinal ganglionic cells studied by us without exception and independently of the area from which the tissue was taken. Thus, according to the direction of the growing nerve fibres, it is quite possible to determine the side of the explant which in the organism was directed towards the exit of the optic nerve.

All the nerve fibres growing in the zone of growth of warm-blooded organisms (young rabbit, chick) are about the same size, diverge radially, branch, divide, form collaterals, cross and overlap one another. The fibres terminate in distal cones of growth. They exhibit many varicosities. Living nerve fibres are very delicate and highly refractive of light. They show *in vivo* a characteristic winding neurofibriallary striation.

The axons of the ganglionic cells in Amphibia (adult axolotl) growing in the zone of growth are distinguished by their thickness. They emerge radially from one of the sides of the explant, some of them showing a repeated dichotomic division. The length of such axons grown *in vitro* may reach 1 cm. The neurofibrillæ of the axons of the ganglionic cells of the retina in the axolotl subjected to vital study are recognized as straight, sharply outlined parallel bundles. The fibres of these cold-blooded organisms *in vitro* revealed a process of longitudinal splitting which often was incomplete, giving an illusive appearance of anastomoses or synditial connexions. In the old cultures there were still observed peculiar swellings, 'joints', along the course of the nerve fibre which, obviously, were of retrogressive character.

The growing retinal nerve fibres of the adult crucian showed *in vitro* a different modification. At the initial stage of growth they formed a herb-like bundle consisting of a mass of nerve fibres closely applied to one another. They passed to the zone of growth smoothly twisting and sometimes reaching also 1 cm. in length. Such a long bundle of nerve fibres reminded one of a small branched tree composed of fibres interlacing and crossing at a definite point (chiasma ?) and terminating in thin cones of growth. The neurofibrillæ in the axon clearly seen *in vitro* were twisted along their course corkscrew fashion, and showed an aspect of stretched spirals repeating the general outline of the nerve fibre.

The growth and regeneration of axons (and probably of the differentiation of the nerve cell in whole) are caused not so much by chemotaxis[1], the difference of electric potentials[2] or stereotropic conditions of the surroundings[3], as by the spatial polarity of the ganglionic cell itself. The polarity is due to its albuminous structure manifested in a definite orientation of the neurofibrillæ.

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Demonstration of Alkaloids in Solanaceous Meristems

A GENERAL concensus of opinion among investigators has agreed that Bouchardat's reagent is the most reliable among many tried for the cytochemical demonstration of alkaloids. It is a general alkaloid reagent, with no specificity, and consists of 1 per cent iodine dissolved in 1 per cent potassium iodide. It colours proteins very heavily. With practice, the red tint and fine grain of the alkaloid precipitate can be readily distinguished from the flocculent brown of the protein. Errera[1] devised the further expedient of treating parallel preparations with a 5 per cent solution of tartaric acid in alcohol. This dissolves out the alkaloids so that a clear distinction should be apparent in alkaloid-containing tissues with and without such pre-treatment. No difference will be apparent if the iodine precipitation is due to protein.

These devices enable a rapid and reliable determination of the distribution of alkaloids to be made with mature parenchymatous and similar tissues, where the alkaloid precipitates can be seen in the large vacuoles surrounded by the thin protein layers of the cytoplasm. In attempting to apply them to the root and stem meristems of solanaceous plants, serious difficulty was encountered. It was desired to determine as accurately as possible the moment of the first appearance of alkaloids in the germinating seedling, the resting embryo being itself alkaloid-free. The detection of minute amounts of alkaloid among the copious protein of the meristematic cells proved quite impracticable. Attempts at a micro-extraction with ammoniated chloroform, followed by a Vitali-Morin[2] treatment of the extract were not successful owing to the moisture contained in the tissue. It was found, however, that a good separation of alkaloid and protein could be achieved if the cellular membranes were first broken down. This was done by treating the tissue to be examined with ether. The small piece of excised tissue, root-tip, etc., is placed upon a microscope slide and surface dried with filter paper. One drop of ether is then dropped on it with a glass rod and allowed to evaporate. Evaporation of the ether must be complete, or iodine will be precipitated from the reagent as minute black crystals. When the ether is completely gone, the slide is transferred to the stage of a microscope and the tissue focused under a half-inch objective. One drop of Bouchardat's reagent is then applied from a glass rod and the tissue is kept under observation from the moment of application. If alkaloids are present, a red cloud diffuses out of the tissue and spreads for a short distance into the surrounding fluid. The brick-red colour and finely granular appearance are very characteristic and are due to the alkaloid which is now free to escape as water-soluble salts from the denatured proteins. The reaction is transient and the tissue should be kept under observation from the moment of application of the reagent. Tissues containing abundant alkaloid give dense reddish clouds of precipitate; after the extraction of the alkaloids with 5 per cent alcoholic tartaric acid no red cloud is produced.

Very small amounts of alkaloid associated with an excess of protein can be quickly and easily discovered in this way and minute quantities of tissue, such as a single meristem, suffice.

This technique has been applied to germinating seedlings of *Datura stramonium*, *D. stramonium* var. *inermis* and *D. tatula*, also to older roots of *Atropa belladonna*, with pleasingly definite results. *Datura* seedlings were germinated on washed sand and examined as soon as the radicle began to push through the testa, and at subsequent stages. Roots 1 and 2 mm. long were found to be entirely devoid of alkaloid: roots 3 mm. long gave a slight reaction and longer roots gave copious reactions. The cloud appeared from the surface of the treated root just behind the root-cap, that is, from the meristem proper. There was no reaction from the root-cap itself, nor, at first, from the elongation zone. In older roots this also began to give a reaction, but in roots carried on to a stage of starvation, the reaction disappeared even from the meristem. The results were identical for all three varieties of *Datura* used.

As soon as the cotyledons were expanded, the shoot meristem was also examined. A positive reaction for alkaloids was given by the smallest apex that it was possible to dissect out and also by the rudiments of the first two leaves. The cotyledons and the hypocotyl, intervening between the shoot and root meristems, gave no reaction at this stage. The amount of precipitate formed from the shoot apex was noticeably smaller than that from the root: but in *A. belladonna* seedlings, grown in sandy soil to a six-leaved stage, the relations were reversed. A copious red cloud was obtained from the dissected-out stem tip and little or none from that of the root.

These results confirm those of the older investigators of similar materials, and indicate that alkaloids appropriate to the species are very rapidly synthesized by cells in a phase of active metabolism and growth. The effectiveness of the ether treatment suggests that

they are formed within incipient vacuoles, or at least within restricting membranes, in agreement with Chaze's[3] *Nicotiana* results obtained by different methods. Accumulation in the large vacuoles of storage tissues is a later development.

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Lethal Effects of D.D.T. on Young Fish

DEATHS of young fish have been noted in waters which have been sprayed with D.D.T. as an anti-mosquito measure[1]. The following observations on the so-called Kafue 'bream' (*Tilapia kafuensis*), a common and hardy fish of Rhodesia, are of interest in view of the growing importance of this and other fish in the diet of Central African inhabitants and the official encouragement in fish farming of this species.

In the first experiments, young fish about 1 in. long were put in clear water in pint jars. one to each jar, and a D.D.T. in paraffin solution (5·2 per cent para para) was applied in various concentrations. In mosquito work it is usual to specify the D.D.T. concentration at so much per unit surface area, as the larvæ are essentially surface-livers, but with fish, concentration per volume of water is also important as D.D.T. is very slightly soluble in water, and fish, continuously filtering water in their respiratory actions, are in a favourable position to absorb the poison. Using a concentration equivalent to 1 oz. pure D.D.T. per acre, a normal effective larvicidal concentration (about 1 part of D.D.T. to 18 million of water in this case) all the fish died within twenty-four hours. With 0·5 oz. per acre (1 : 36 million) 80 per cent died in one day and the rest within the next two days; with 0·25 oz. per acre all were dead within 4–5 days.

In control experiments using pure paraffin in equal quantities and also using untreated water, fish lived ten or more days before dying, presumably of starvation. A few similar experiments suggested that gammexane powder was also toxic. Further experiments were conducted using twenty-gallon aquaria with clear water, mud bottoms but very slight weed growth, which formed a more normal environment for the fish. At a dose of 1 oz. per acre (here only 1 in 48 million because of the deeper vessel) nearly all the fish died within one day; at this concentration and a higher one of 3 oz. per acre some dragon-fly larvæ survived although the fish died. There was no mortality at 0·33 oz. per acre (1 : 150 million).

Experiments were then carried out in fish pools of about 40 sq. yd. area and 2 ft. deep. The water in these pools was largely kept up by sub-soil seepage and they were weedy, had very muddy bottoms and a rather heavy deposit of debris. In them no deaths were recorded until the D.D.T. concentration was 3 oz. per acre (1 : 25 million) when there was approximately 70 per cent mortality within four days and then no further deaths. The comparatively heavy dose necessary in this case suggests some absorption or decomposition of the D.D.T. on vegetation or mud. Even here, however, the lethal dose is within the range used in anti-mosquito measures[2]. Moreover, the shallow waters in which these young fish occur are just those places likely to be given most attention in the control of mosquitoes. It is clear that D.D.T. applications should be made only with great caution in waters which are breeding-grounds of fish, of this species at least, where they are an important item of diet.

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Food and Digestive Organs of Lamellibranchs

IN his comment on my note in *Nature*[1], Prof. Yonge[2] raised the following points: (1) that histological evidence for the secreting function of the digestive diverticula is lacking; (2) that the passage of the chlorophyll colouring matter from the blood into the lumen of the gut through the cells of the digestive diverticula is merely the passage of the indigestible residue after intracellular digestion; (3) that extracellular protease and the style cannot co-exist; (4) that extracellular protease in lamellibranchs is derived from cytolized or burst phagocytes; (5) that the presence of any significant quantity of animal matter in the gut of lamellibranchs is rare.

The histological evidence is far from lacking[3,4]. Bouin-, Flemming- (without acetic) and Bouin-Duboscq-fixed material showed different stages in the formation of the secretion globules. In such preparations it is easy to note the dropping off of cell-fragments loaded with globules into the lumen of the tubules. From the beginning it was evident to me that the cells of these organs are of the holocrine type and that the replacement of the ripe fragmenting ones is continuously taking place from nests of replacement cells. It is noteworthy that such globule formation and fragmentation of diverticula cells has been previously recorded by Prof. Yonge[5] (*loc. cit.*, p. 41). Nevertheless I have been after a positive experimental proof.

In his explanation of the passage of the chlorophyll colouring matter from the blood into the lumen of the gut through the cells of the digestive diverticula Prof. Yonge raised a very problematic point, namely, the fate of chlorophyll. However, one can only ask what evidence have we that 'intracellular digestion' does really take place in this case and whether it is possible that a substance like chlorophyll in solution after undergoing 'intracellular digestion' would have an indigestible residue of a colour and freshness similar to those of the unaffected material[4].

The question of the crystalline style has often been raised. In his reasoning, however, Prof. Yonge does not deny the presence of extracellular protease. He only endeavours to derive it from a phagocytic source. This admission affects his argument very seriously. In this connexion I would like to mention that what seems to be of fundamental importance for the existence of the style is the degree of protection afforded to it by the surrounding tissues. In the case of *Unio*, where the style lies simply in a groove, a few hours of starvation in filtered pond water are enough for the disappearance of this structure. In *Tridacna*, on the other hand, where the style lies in a definite cæcum with only the head protruding into the stomach, eight days of starvation in filtered sea-water scarcely gave any comparative difference in either the length or the thickness of the style (see also Nelson[6], Edmondson[7] and Yonge[8]).

The suggested explanation for the presence of 'semi-digested animal remains' in the gut of some lamellibranchs brings us to the very important point of the differentiation between phagocytes, which admittedly can occur in the lumen of the gut, and fragments of the ripe holocrine cells. This has been discussed at some length in a preliminary communication[3]. It has been pointed out in that communication that what Prof. Yonge[9] in his study of *Tridacna* took to be 17 zooxanthellæ (7 μ each) ingested in one amœbocyte of 10 μ only (*loc. cit.*, Text-fig. 5, p. 296) is in reality nothing but a mass of secretion globules adhering together. It has been pointed out also that similar clumps of globules or fragments of ripe holocrine cells are of regular occurrence in all the other forms examined (*Pinctada* sp., *Mytilus* spp., *Ostrea* spp.). These fragments sometimes look like phagocytes and are often seen collecting round the food material in the stomach. This recalls Prof. Yonge's observation on the stomach contents of *Ostrea* fed with an emulsion of olive oil. Only what he takes to be phagocytes, I consider nothing but fragments of ripe diverticula cells in virtue of their origin referred to above and the rather quick dispersal of the individual globules they contain. The reference to these structures in the lamellibranchs, as coming from the blood, is not in accord with the facts (see also Potts[10], p. 7).

As to the rarity of "any significant animal matter in the gut", unfortunately Prof. Yonge did not refer to the time at which the search of the gut contents was made. That the search should be made soon after feeding was adequately stressed[1]; and it is no wonder that Fox *et al.*[11] and Yonge[12] have missed such animal matter. The first authors have been examining *Mytilus* 5–8 hours after active feeding had stopped (*loc. cit.* Footnote, p. 20) and Yonge has been examining the gut contents of *Cardium* and *Mya* two days and six hours respectively after being fed with dog-fish blood corpuscles (*loc. cit.*, p. 711). On the other hand, Nelson[13] has been searching some of his material within 2 minutes from the moment active feeding was stopped. It is worthy to add that Edge[14], in his work on the rates of digestion of marine invertebrates, gave the time required for food to pass through the whole of the digestive tract of *Ostrea lurida* as 3 hours, *Mytilus californianus* also 3 hours and *Cardium quadraginarium* as 11 hours (see also Dodgson[15]).

In conclusion, I thank Prof. Yonge for his compliment[2] and wish to register that without the biochemical investigation carried out by Dr. J. J. Mansour-Bek[16] the results of my morphological and biological studies would have been very difficult to substantiate.

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Extracellular Proteolytic and Lipolytic Enzymes of Some Lamellibranchs

PROF. YONGE[1], in commenting on Mansour's note[2] in *Nature*[3], endeavoured to maintain two rather contradictory views, namely, (1) that the extracellular proteolytic and lipolytic enzymes recorded from the stomach juice of some lamellibranchs are derived from cytolized or burst phagocytes; (2) that extracellular proteolytic and lipolytic enzymes are absent from the stomach juice of lamellibranchs.

In maintaining that the extracellular proteolytic and lipolytic enzymes, recorded by different authors[3,4,5], are derived from phagocytes, Prof. Yonge cites the work of Takatsuki[6]. The incompleteness of the experimental data of this author does not allow a comparison between his results and mine to be made. However, it is clear from his figures that the proteolytic and lipolytic actions of the concentrated extract of the amœbocytes are much weaker than those reported from the stomach juice of the same sp.[3]. This point is against Yonge's contention unless it can be definitely proved that phagocytes on cytolysis or bursting give off their intracellular enzymes more freely than when ground up and extracted.

The claim that extracellular enzymes are absent from the stomach juice is supported by Prof. Yonge by referring to Vonk[7], Graham[4] and Fox *et al.*[8] as adherers to the same view. Vonk, in his work on phagocytosis of carmine particles by the digestive diverticula of *Ostrea*, came to the conclusion that free protease was absent from the stomach juice simply on the strength of the results of Heymann[9] who found no action of the stomach juice on fibrin and egg-albumen, two substrates which have since been proved to be unsuitable for the detection of small quantities of proteolytic enzymes[8]. As to the lipolytic enzymes, Graham did not deny their presence in a free state in stomach juice; he only ascribed them to a phagocytic source. Fox *et al.*, on the other hand, only used extract of the whole alimentary tract. They attributed the proteolytic action of this extract to the 'intracellular enzymes' of the diverticula. Their investigation was never extended to the pure stomach juice, being *a priori* satisfied that no free proteolytic enzymes occur in the lamellibranchs.

In conclusion, I would like to mention that I have no doubt whatever that extracellular proteolytic and lipolytic enzymes occur in the stomach juice of the lamellibranch species I examined. The point at issue now is the source of these enzymes. The morphological studies of Mansour[11] which I am fully acquainted with do not leave any doubt that the cells of the digestive diverticula, of the species he examined. do fragment and their fragments loaded with globules reach the lumen of the stomach. It is not unlikely that these fragments, which sometimes resemble phagocytes, are the direct source of the free enzymes in question.

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The Perfect Stage of *Botrytis squamosa* Walker

In mid-November, 1945, two cultures were made on Dox's agar of *Botrytis* conidia from conidiophores produced on onion leaves. These had been sent by Mr. D. E. Green of the Royal Horticultural Society, Wisley, as typical specimens showing symptoms of attack by *Botrytis squamosa* Walker. Apothecia were observed in one culture on January 7, 1946, and more were produced during the period January 7–February 15. The other culture also produced a few apothecia during the period January 20–February 10.

Single ascospore cultures on Dox's agar developed sclerotia which produced conidiophores typical of *Botrytis squamosa* as described by Walker[1] and, in England, by Hickman and Ashworth[2]. Leaf infection on onion seedlings was obtained by ascospore inoculation, and the fungus was re-isolated from the lesions which, under damp conditions, became covered with conidiophores.

Sub-cultures were made and apothecia again obtained.

It is thought that this is the first record of the perfect stage of *Botrytis squamosa* Walker, and that its characters are consistent with those of a Sclerotinia.

I am much indebted to Dr. W. A. R. Dillon Weston, under whose supervision this work was done. I also wish to thank Prof. F. T. Brooks, Mr. W. C. Moore and Dr. A. Smith for helpful advice and criticism, and Mr. D. E. Green for sending the specimens. The work was carried out with the financial support of the Agricultural Research Council.

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Defence Against the Atom Bomb

In a recent article[1], D. G. Christopherson gives an impression that the disastrous effects of atomic weapons have been grossly over-rated. His main points are that the atomic bomb is effective mostly against large cities, and that dispersal would leave a density of population against which atomic bombs would be too costly to use, provided there were adequate shelters and an efficient warning system.

It seems to us that Mr. Christopherson's conclusions cannot be maintained if one remembers the following facts:

(1) The power of atomic bombs against cities has been demonstrated and is not questioned in Mr. Christopherson's note. It is true that shelters would reduce casualties from collapse of buildings, injuries from glass and other fragments and flash-burn. There remains even then a smaller area in which the blast intensity and the intensity of penetrating radiations are so high that adequate protection would not be practicable. Present knowledge of the mechanism of radiation injuries leaves little room for the hope, expressed by Mr. Christopherson, that an effective treatment after exposure could be found, except in marginal cases.

(2) Even if one accepts the statement that large cities are undesirable, their dispersion in a manner governed not by the natural growth of other units, but by the fear of atomic war, would represent a most drastic dislocation of the economic life of Great Britain. To start dispersal when war is imminent would clearly be too late. Indeed, a group of American scientific workers have seriously discussed a plan[2] of dispersing all major cities of the United States. The data given in their article make it clear what a formidable undertaking this would represent.

Great Britain is, of all big powers, the least favourably placed in this respect, because of the limitations in resources and building materials, high centralization, dependence on imports, and because of the relatively high population density that would remain even after perfect dispersal. It must be remembered that, for protection against atomic bombs, one must disperse not only dwellings, but also all other important installations, such as ports, transport centres and warehouses, power stations and factories, unless they can be rebuilt underground. A comparison of the amount of rebuilding required for this with the number of houses involved in the present building programme gives an idea of the staggering magnitude of the job.

(3) Dispersal of all large cities would still be insufficient if it turned out that atomic bombs could be used without prohibitive effort against the largest remaining units. Thus one's plan for dispersal must depend on the cost of a bomb. This should not be estimated by comparison with the published figures for expenditure on the American project, which deliberately put speed and certainty of operation before economy. It is known from the Smyth Report that the effort was spread over three independent lines of attack, of which each is now known to have been successful. The facts published in the Smyth Report alone are sufficient to save anyone embarking now on a similar project much of the expense of development work.

In particular, Mr. Christopherson's argument based on power-consumption is a fallacy. The figure of 1,000 kilowatts which Smyth quotes as being associated with a production-rate of one gram of plutonium per day refers to power *produced*, not *consumed*. It should therefore appear on the opposite side of the balance sheet, particularly when once the remaining engineering problems in the way of utilization of atomic power have been solved.

(4) In discussing the protection by shelters and a warning system, it must be borne in mind that the warning, to be effective, must come into action on the approach of a single aeroplane or rocket. In the case of the latter, if any warning can be given in advance the available time must be exceedingly short and at best sufficient for people to drop what they are doing and to run for shelter. An enemy can therefore cripple the life of a country by sending at frequent intervals aeroplanes, rockets or other missiles of which only a few need carry atomic bombs. The experience of the War has shown that in these circumstances the warning system becomes useless, since people will soon refuse to take cover.

(5) The difficulties connected with a warning system are enhanced if it becomes necessary to guard against a surprise attack of the Pearl Harbour type. In that case the warning system would have to be alerted in peace-time and might have to come into action on the approach of single unidentified aeroplanes and other objects. To take this step in peace-time could in itself have bad effects on international relations.

(6) Lastly, we must remember that the very idea of an atomic bomb is only six or seven years old. To base one's ideas, or even a complete reorganization of a country, on the assumption that atomic bombs will never be more effective or less costly than they are now, would be as shortsighted as it would have been in 1938 to assume that atomic weapons are impossible.

We do not wish to over-state the effect of such bombs. We do not wish to assert that all civilized life will stop if there is a major atomic war. But it seems to us clear that in all probability the effects of such a war would be such a serious blow to civilization that the problem of ruling out atomic warfare (and also, of course, warfare using other new means of mass destruction) should be regarded as the foremost political problem of our time. Any attempt to blind ourselves to the seriousness of the dangers is liable to diminish the sense of urgency that alone will ensure a determined and sustained attack on the problem.

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Meson Production in Copper

Cloud-chamber photographs of associated penetrating particles produced in air and lead, have already been obtained by various observers[1-5]. In the course of taking photographs of cosmic rays by a randomly operated cloud-chamber placed in a magnetic field of 1500 gauss with a lead absorber 1·5 cm. thick at the centre of the chamber, photographs have been obtained showing pairs of penetrating particles diverging from a point in the field coils. One such photograph is reproduced.

Both the particles A and B have energies 5×10^8 e.V., and neither produces electron cascade inside the absorber. They can be interpreted in the following ways: (*a*) both the particles A and B are mesons produced by a non-ionizing agent; (*b*) one of the mesons creates the other and the two together appear as a pair; (*c*) the particle A is a proton, which acts as a primary for the creation of the meson B.

The point in favour of interpretation (*c*) is that the particle A has produced heavier ionization than that in the other tracks, and can be interpreted as a proton the energy of which is somewhat less than 3 M (M is rest energy of proton), where the ionization due to the proton

PAIR OF PENETRATING PARTICLES OF ENERGY E GREATER THAN 5×10^8 e.V. TRAVERSING LEAD ABSORBER

increases rapidly with decreasing energy. According to Hamilton, Heitler and Peng[6], a proton of this energy can still produce a meson.

I wish to thank Dr. R. L. Sen Gupta for lending the apparatus for the investigation and for his help in the interpretation of the photographs.

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Phase Angle Determination in X-Ray Crystallography

THE extensive programme of work on the extra reflexions caused by thermal motion of the crystal lattice, which has been carried out by Lonsdale and her colleagues at the Davy Faraday Laboratory, has shown that these occur, not rarely as was at first thought, but in all crystalline substances. The technique of experimental observation of these reflexions has been so developed that at the present time an adequate survey of any particular crystal can be made in a reasonable time, using standard laboratory equipment.

The observation has already been made[1] that the shape of the diffuse reflexions gives valuable information regarding the orientation of chain molecules in the unit cell, and this rapidly applicable technique is likely to find increasing use in future analyses. The question naturally arises whether a more detailed study of the diffuse reflexions would give information regarding the phase angles of the parent Bragg reflexions.

In the case of non-centro-symmetric reflexions, no obvious relationship is forthcoming. When the reflexion forms one of a centro-symmetric group, however, its structure factor can be written in the form:

$$F(h,k,l) = \sum_r f_r \cos 2\pi\left(h.\frac{x_r}{a} + k.\frac{y_r}{b} + l.\frac{z_r}{c}\right),$$

and the determination of the phase angle degenerates into the determination of the sign of $F(h,k,l)$. Now using only Bragg reflexions, the only points at which $F(h,k,l)$ is observable are those for which (h,k,l) are integers. If some method of observing the function at intermediate values were available, the changes in sign would be indicated by the vanishing of the function.

The observation of regions of diffuse reflexion provides precisely this information, and, by a careful analysis, the approximate value of $F(h,k,l)$, over large regions of reciprocal space, can be found. Unfortunately, the existence of a point of zero intensity is seldom unequivocal, owing to the presence of other background radiation and only approximate identity of $F(h,k,l)$ and the dynamical structure factor, so that *changes* in sign derived from this technique may be doubtful. In a large number of cases, however, the diffuse connexion is strong enough to make it certain that there is *no* zero of $F(h,k,l)$ in the region of reciprocal space between adjacent Bragg reflexions, and in this case it can be stated that the values of $F(h,k,l)$ have the *same* sign.

It is not suggested that a great number of reflexions can have their phase angles determined by this method, but that a sufficient number may be determinable to make the preliminary stages of a structure analysis a less hazardous operation than is now the case. The usefulness of small numbers of planes with associated phase angles has been demonstrated in the recent work of Boyes-Watson and Perutz on horse hæmoglobin[2]. Although the phase angles determined by the above procedure are only relative (that is, their relation to the positive term $F(0,0,0)$ is still unknown), this should not lead to difficulty, since a Fourier synthesis, taken in conjunction with known stereo-chemical data, will usually clear up this point.

Through the courtesy of Dr. K. Lonsdale and Mr. P. G. Owston, the method has been applied to hitherto unpublished photographs of oxalic acid-dihydrate. The pairs of planes: $(0,1,11)$, $(\bar{1},0,11)$; $(\bar{4},1,7)$, $(\bar{5},0,7)$; $(5,1,4)$, $(5,0,5)$; $(3,1,0)$, $(4,0,0)$; $(\bar{4},1,9)$, $(\bar{4},0,8)$ and $(1,1,\bar{10})$, $(1,0,\bar{11})$, were found to have definite diffuse connexion, and an examination, using the known atomic co-ordinates, shows that their structure factors have, in each case, the same sign. The author wishes to express his sincere thanks for permission to use these data.

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Glycol Splitting by Hydroxyl Radicals

RECENTLY[1] I suggested, on theoretical grounds, that the splitting of α-glycols to aldehydes or ketones by means of lead tetra-acetate was due to dehydrogenation by free acetate radicals.

$$\begin{matrix} R_1R_2C\text{—O—H} \\ | \\ R_3R_4C\text{—O—H} \end{matrix} + \cdot\text{O—COCH}_3 \rightleftharpoons \begin{matrix} R_1R_2C\text{—O}\cdot \\ | \\ R_3R_4C\text{—O—H} \end{matrix} + \text{H—O—COCH}_3$$

$$\begin{matrix} R_1R_2C\text{—O}\cdot \\ | \\ R_3R_4C\text{—O—H} \end{matrix} \rightleftharpoons \begin{matrix} R_1R_2C\text{—O—H} \\ | \\ R_3R_4C\text{—O—H} \end{matrix} + \begin{matrix} R_1R_2C\text{—O}\cdot \\ | \\ R_3R_4C\text{—O}\cdot \end{matrix} \rightarrow \begin{matrix} R_1R_2C{=}O\ + \\ R_3R_4C{=}O \end{matrix}$$

If this hypothesis is correct, it follows that the free hydroxyl radical, $\cdot$OH, which Haber and Weiss[2], and more recently Baxendale, Evans and Park[3] have shown to be present in Fenton's reagent (hydrogen peroxide plus a ferrous salt), should be capable of acting in a similar way. Fenton[4], however, had shown that his reagent oxidized ethylene glycol to glyoxal and glycerol to either glyceraldehyde or dihydroxyacetone. I have therefore re-examined these reactions, and by using dimedone as a diagnostic reagent, have shown that whereas the main oxidation proceeds:

$$CH_2OH\text{—}CH_2OH \rightarrow CHO\text{—}CHO,$$

some formaldehyde is liberated both from ethylene glycol and from glycerol. 2 · 3-Butylene glycol similarly gives acetaldehyde as well as diacetyl, whilst pinacol yields acetone.

In all these cases the extent of glycol fission is enhanced by working in solutions strongly buffered with sodium acetate and acetic acid.

Under Fenton's reaction conditions, which employ reagents in concentrated solution with molecular hydrogen peroxide in large excess, the free hydroxyl radical would have a very short life. Theory indicates that this would be most unfavourable for glycol fission, which requires rather the slow production of free radicals in very low concentration. These positive preliminary results indicate, however, that glycol splitting may be quite a normal reaction of free neutral radicals in solution, and not specifically a reaction of lead tetra-acetate, or of periodic acid; and further experiments are being conducted to explore the range of reagents which may be used, and the reaction conditions which will favour high reaction yields.

The concurrent formation of both acetaldehyde and diacetyl from 2 : 3-butylene glycol by the action of Fenton's reagent may indicate that both the C—H and the C—O—H groups of alcohols can be dehydrogenated directly by neutral hydroxyl. One of these reactions, however, may be a second-stage process involving molecular hydrogen peroxide; for example:

$$R_1R_2CH\text{—O}\cdot + HO\text{—}OH \rightarrow R_1R_2C{=}O + H_2O + \cdot OH.$$

The formation of acetone from pinacol shows, however, that the primary attack on the C—O—H group of alcohols does occur, and is diagnostic therefore in answering the vexed question[5] of the mode of oxidation of alcohols.

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Polymerization of Methyl Methacrylate

IN a general survey of the polymerization of vinyl compounds using the method previously described[1], we have studied methyl methacrylate, and have found that it presents features of some interest.

Determination of the spontaneous rate of polymerization is difficult since traces of catalyst and inhibitor are formed with great ease either from the monomer or from inseparable impurities. However, the rates of change of viscosity during irradiation (λ 3000–4000 A.) are reproducible, and conform to the kinetic equations given previously, being proportional to $I^{1/2}$ at low intensities, and independent of I at high intensities. Thus we have been able to estimate the velocity constants of chain propagation, transfer and termination with reasonable accuracy. They have the values 150, 0·03 and $1{\cdot}3 \times 10^7$ moles litre^{-1} sec.$^{-1}$ respectively at 25°. The life-time of a growing polymer chain is about 3 sec.

It will be seen that the values for propagation and transfer are about forty times those of styrene, while termination occurs only

ten times as readily. These values imply that the molecular weight is determined by the ratio of propagation to transfer, remaining almost constant up to very high rates of polymerization. Thus the rate at 25° giving a mean molecular weight only 33 per cent less than that of the 'transfer polymer' is sixty times the corresponding rate for styrene.

Our value for the velocity constant of propagation is very much less than that which may be deduced from Melville's[2] experiments on the sensitized polymerization of methyl methacrylate in the gas phase ($\sim 3 \times 10^6$ at 20°). This corresponds to a frequency factor of 3×10^{10}, assuming that the energy of activation for propagation is 5-6 cal. (and it is not likely to be less). Since the propagation reaction is certainly sterically hindered, this value must be too high. In any event, it is not consistent with Burnett and Melville's[3] results for vinyl acetate (in which there is less hindrance), which lead to a frequency factor of $1 \cdot 35 \times 10^6$.

In the photopolymerization of liquid methacrylate a rapid polymerization is observed after the light has been cut off. This is independent of the normal photochemical after-effect. A similar result is obtained when the vapour is subjected to a silent electrical discharge for a few minutes. None of these features can be attributed to surface effects. All our results can be explained if a catalyst is formed by the action of light or the electric discharge.

Melville[2] has previously observed a somewhat similar phenomenon in the photopolymerization of methacrylate vapour, and has concluded that the growing chains are of special type which do not terminate, and which are not radicals but contain activated double bonds. We do not find this concept necessary in our case, as the chains appear to be quite normal. Furthermore, Melville's evidence suggests that his results can also be explained by the formation of catalyst, or removal of inhibitor, by light, together with absorption of monomer by the film of polymer. This interpretation seems preferable to us, as Melville's activated double bonds do not appear to conform to current physical ideas.

A full account of these experiments will be published elsewhere in due course.

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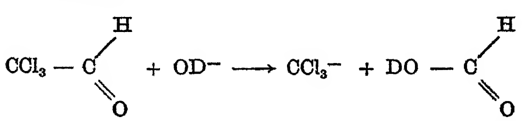
Hydrolysis of Chloral in Heavy Hydrogen Water

IN the presence of an alkali, chloral undergoes a fission at the C—C bond with the formation of chloroform and an alkali formate. This communication gives a preliminary report on the investigation of this reaction in the presence of heavy hydrogen water. 1 c.c. of a solution containing 0·002 mole of chloral hydrate is mixed with 1 c.c. of a solution containing 0·002 mole of sodium hydroxide. The reaction is complete within one minute at 30° C. and, after this period, the reaction mixture is frozen. The chloroform and the water are removed by pumping off the vapours of these substances from the frozen mixture. When the sodium formate which remains in the vessel is perfectly dry, it is decomposed by the action of heat. Sodium oxalate and hydrogen are formed and the latter is then converted to water. The excess density of this water is determined by the micro-pyknometer method of Gilfillan and Polanyi[1]. The results of experiments in the presence of normal water and of heavy hydrogen water respectively, are listed below. The excess density of the original heavy water, allowing for the exchange between the hydrogen of the hydroxyl groups of the reagents and that of the water was 2650 p.p.m.

Excess density in p.p.m.	
Normal water	Heavy water
0	41
0	785
0	124
0	280

The results of experiments in the presence of heavy hydrogen water are rather variable; but as the average excess density is only about 10 per cent of the excess density of the original heavy water, the hydrogen in the formate ion is most probably the same as that in the aldehyde group of the original chloral molecule. The mechanism presumably involves an attack on the carbon of the aldehyde group by the hydroxyl ion, followed by a fission of the C—C bond and formation of a CCl_3^- ion.



The process is then completed by the neutralization of the formic acid and reaction between the CCl_3^- ion and water.

$$OD^- + H{-}COOD \longrightarrow DOD + H{-}COO^-$$
$$CCl_3^- + DOD \longrightarrow DCCl_3 + OD^-$$

The observed excess density in the case of experiments carried out in the presence of heavy hydrogen water cannot be attributed to the exchange of hydrogen between the formate ion and water as this is a very slow process[2]. The hydrolysis of the heavy hydrogen chloroform would lead to the formation of a formate ion containing heavy hydrogen,

$$DCCl_3 + 4NaOH \longrightarrow D{-}COONa + 3NaCl;$$

but titration of the final reaction mixture with a standard silver nitrate solution shows that, under the experimental conditions, this reaction does not occur to any appreciable extent. It appears that the interchange of hydrogen between the water and the hydrogen of the aldehyde group in the chloral molecule is the most likely explanation of the results.

The corresponding exchange in the case of acetaldehyde is slow[3], but in the chloral molecule the CCl_3^- group may have an activating effect on the hydrogen of the aldehyde group. The variable results which have been obtained are believed to indicate that the exchange occurs at a fairly rapid rate under alkaline conditions. This latter point is being investigated.

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Aug. 6.

[1] Gilfillan, E. S., and Polanyi, M., *Z. phys. Chem.*, A, **166**, 255 (1933).
[2] Small, P. A., and Wolfenden, J. H., *J. Chem. Soc.*, 1811 (1936).
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Central Institute of Management

WITH reference to a report of the committee appointed by the President of the Board of Trade under the chairmanship of Sir Clive Baillieu entitled "A Central Institute of Management"[1], it appears that the content of management under the proposed Institute of Management will cover the "common, broad functions of management" and will embody both "research" and "training and education". It is assumed that these will embrace the general principles of management or administration, such for example as the principle of delegation of authority, since they are current throughout all administrative or managerial fields.

With regard to the various fields of management or administration these are to be the provinces of the *ad hoc* bodies concerned, where such exist, and may be divided into two main classes: public management and non-public management. Under public management may be included central and local government administration, which involves, *inter alia*, the administration of the defence forces, social administration and the management of the public utilities. Within the scope of non-public management lie such special fields as industrial administration, commercial or business administration, the administration of agriculture and institutional administration. Within the latter class may be grouped such functions as ecclesiastical administration and the administration of learned bodies both scientific and otherwise.

Among the activities of the Central Institute of Management are to be the "developing of organization in spheres of management not already covered" and the "developing of new organizations wherever necessary". The conjoint study of the management or administration of technical learned bodies, such as scientific and technical societies, institutes and associations on one hand, and of research associations on the other, has long been neglected. In view of the ever-increasing importance of science, in the development and dissemination of which the scientific and technical learned bodies play an essential and unique part, I suggest that the Institute of Management might consider the setting up of an affiliated body for this purpose in the form of an institute or association of professional administrators of such scientific and technical bodies.

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[1] *Nature*, **157**, 601 (1946).

Charles Mason and Jeremiah Dixon

DURING recent years, I have published articles[1] on Charles Mason and Jeremiah Dixon, attempting to present their survey of the Maryland-Pennsylvania boundary (1763–1768), as a chapter of contemporary science and technology in Great Britain. The work is being continued and extended, and the American Philosophical Society has made a grant of funds to secure copies of source material dealing with the careers of the two men.

I have established correspondence with a number of scholars in Great Britain and now wish to extend my contacts to others who may know of records of the two astronomer-surveyors and of the equipment they used.

Information is needed about the early training of the two. Where were they from the spring of 1762 to midsummer of 1763? Where did Mason live while working for the *Nautical Almanac* during the 1770's? Why did Mason leave England and migrate to Philadelphia during the 1780's? What did Dixon do during the 1770's, the last years of his life? And where are records of their personal lives, their scientific and technological work, and of their instruments to be found other than in publications of the Royal Society and in the *Nautical Almanac*?

Suggestions will be duly acknowledged and credited.

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[1] "Pennsylvania History", **6**, 205–220; **11**, 155; **12**, 24. *Proc. Pennsylvania Acad. Sci.*, **18**, 72; **19**, 79. *Scientific Monthly*, **62**, 541.

FLUOROACETATES AND ALLIED COMPOUNDS

By Dr. H. McCOMBIE and Dr. B. C. SAUNDERS
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WE have recently recorded[1] the synthesis and examination during the War of highly toxic fluorine compounds having powerful miotic action, containing the >POF group and known as fluorophosphonates. In the present communication a brief account is given of extensive work on the synthesis and examination of toxic fluorine compounds of an entirely different type carried out at Cambridge during the War by an Extra-Mural Ministry of Supply research team working under our direction. These compounds contain, in general, the $—CH_2F$ group, and have usually been spoken of collectively as the 'fluoroacetates'. For security reasons during the War, this work was not published, though reports (which were also made available to American workers) have from time to time been submitted to the Ministry of Supply.

Until this work was undertaken, no very serious attention had been paid to the preparation of the fluoroacetates as a class, or to their systematic physiological action. While working on the fluorophosphonates our attention was directed in 1942 to the compound methyl fluoroacetate, FCH_2COOCH_3, by F./O. Sporzynski, Prof. H. V. A. Briscoe and Dr. H. J. Emeléus. A large variety of new types of compounds was then synthesized and examined at Cambridge, and new techniques for introducing fluorine into compounds were worked out. In the course of time, important relationships between physiological action and chemical constitution emerged. Full details and a more complete bibliography will be given in the appropriate journals in due course.

The first compound to be investigated in detail was naturally methyl fluoroacetate (MFA), and extensive work was carried out in this laboratory to select the best conditions for its preparation. It was found[2] that if methyl chloroacetate and potassium fluoride were heated together in an inclined rotating autoclave for 4 hours at 220°, a yield of 54 per cent of methyl fluoroacetate was obtained, or 60 per cent allowing for recovery of methyl chloroacetate (a speed of 280 rev. per min. and the inclusion of glass marbles ensured thorough mixing). This method formed the basis of the production of this and related substances on a large scale.

Methyl fluoroacetate, a mobile liquid of b.p. 104° and m.p. *c.* —35°, has an extremely faint odour. Animals did not usually exhibit any symptoms while being exposed to lethal concentrations of this vapour, and no obvious effects were noted until some 30–60 min. (depending upon the concentration) after exposure. Violent convulsions then took place and death usually followed within a few hours[3]. For rabbits and guinea pigs the lethal concentration (L.C. 50) for a 10-min. exposure was of the order of 0·1 gm./m.^{3}. Mice were rather more resistant. Intravenous injection produced symptoms similar to those displayed after exposure to the vapour. Even with large doses a delayed action was observed. The L.D. 50 for rabbits (intravenously) was found to be about 0·25 mgm./kilo.

The toxicities of ethyl, *n*-propyl and *iso*-propyl fluoroacetates were similar to that of methyl fluoroacetate. They were readily prepared by heating the corresponding esters of chloroacetic acid with potassium fluoride in the rotating autoclave*. On the other hand, methyl α-fluoropropionate, $CH_3.CHF.COOCH_3$, and methyl α-fluoro*iso*butyrate, $(CH_3)_2CF.COOCH_3$, showed negligible toxicity. It is interesting to note that these compounds do not contain the $—CH_2F$ group.

Before leaving these simple esters, it may be mentioned that when methyl fluoroacetate was subjected to the Claisen ester condensation[4], it gave the expected methyl α : γ-difluoroacetoacetate, $FCH_2COCHFCOOCH_3$.

Fluoroacetic Acid and Derivatives

Fluoroacetamide, FCH_2CONH_2, a highly crystalline compound, readily prepared by the action of ammonia on methyl fluoroacetate, could be used for characterization purposes. It was obtained in a high state of purity, and then served as a convenient standard substance for the determination of the percentage of fluorine in compounds containing the FCH_2-group. The amide also served as a useful intermediate in an alternative method for preparing free fluoroacetic acid[5] :

$$FCH_2COOCH_3 \xrightarrow[100\%\ \text{yield}]{NH_4OH} FCH_2CONH_2 \xrightarrow[90\%\ \text{yield}]{\text{nitrous fumes}} FCH_2COOH.$$

The values of the L.D. 50 by intravenous injection for fluoroacetic acid, methyl fluoroacetate, and the amide were found to be similar and of the order of 0·25 mgm./kilo for rabbits.

The amide on distillation with phosphoric anhydride gave the nitrile, FCH_2CN. This compound, previously prepared by Swarts by a laborious method, is a mobile liquid of b.p. 80°. Preliminary experiments showed that it was considerably more toxic to rabbits than to smaller animals. Among hitherto undescribed substituted amides[4] which we prepared, the following may be mentioned, $FCH_2CONHCH_3$, $FCH_2CON(NO)CH_3$, $FCH_2CONHCH_2CH_2OH$, $FCH_2CONHCH_2CH_2Cl$, $FCH_2CON(CH_2CH_2Cl)_2$.

Sodium fluoroacetate was prepared with the idea of obtaining a stable water-soluble compound containing the FCH_2CO-group, suitable for feeding experiments with animals[4]. The method of obtaining the salt from methyl fluoroacetate was new.

The following three acyl halides were prepared[5,4] and their toxicities examined.

Fluoroacetyl chloride	FCH_2COCl	Toxicity similar to that of methyl fluoroacetate.
Chloroacetyl fluoride	$ClCH_2COF$	Non-toxic.
Fluoroacetyl fluoride	FCH_2COF	Toxicity similar to that of methyl fluoroacetate.

These findings were in accordance with expectation, and it was becoming obvious that the toxicity was bound up with the FCH_2CO-group, whereas the $—C\begin{smallmatrix}\nearrow O\\ \searrow F\end{smallmatrix}$ group was ineffective. Further confirmation

* A patent for the preparation of methyl fluoroacetate and of fluoroethyl alcohol using a rotating autoclave has been applied for.

of this point was provided by the observation that ethyl fluoroformate, $FCOOC_2H_5$ (which contains the $-\mathrm{C}\begin{smallmatrix}\diagup\!\!\diagup \mathrm{O}\\ \diagdown \mathrm{F}\end{smallmatrix}$ group), was non-toxic. Fluoroacetic anhydride, readily prepared from sodium fluoroacetate and fluoroacetyl chloride, was rather more toxic (by inhalation) than methyl fluoroacetate.

In an attempt to discover whether a combination of fluoroacetic acid and biologically important compounds might give products of increased toxicity and so give some clue as to the fate of fluoroacetic acid in the body, the following were prepared: fluoroacetyl glycine ethyl ester and cholesteryl monofluoroacetate[9]. Both compounds showed fluoroacetate-like activity, but were considerably less potent than methyl fluoroacetate.

Fluoroethyl Alcohol

It was obviously desirable to prepare fluoroethyl alcohol, FCH_2CH_2OH, (FEA), both from the point of view of toxicity tests on the compound itself, and as a starting-point for the synthesis of other fluorine-containing compounds. Swarts[6] was unable to obtain fluoroethyl alcohol by the action of silver fluoride or mercuric fluoride on either ethylene chlorohydrin or ethylene bromohydrin. He ultimately obtained the compound in negligible yield by the tedious method of hydrolysing fluoroacetin (from bromoacetin and mercuric fluoride) for 80 hours with dilute mineral acid. We found[7] that by using the rotating autoclave technique, ethylene chlorohydrin could be easily fluorinated by heating with potassium fluoride at 130°–135° for 4 hours. It may be noted that with sodium fluoride (in place of potassium fluoride) the yields were small. Thus fluoroethyl alcohol became a readily accessible material, and was prepared in quantity using a 10-gallon autoclave.

Fluoroethyl alcohol is a stable, mobile, colourless liquid of b.p. 101°, completely miscible with water and practically odourless. The compound was a convulsant poison like methyl fluoroacetate, and was about equally potent. As in methyl fluoroacetate, the fluorine atom in fluoroethyl alcohol is firmly bound; in the former the fluorine atom is not removed to any extent even by boiling sodium hydroxide solution. This chemical unreactivity of the fluorine atom of the FCH_2-group is shared by many of the compounds mentioned in this communication. This renders decontamination extremely difficult where this class of toxic substance is concerned. For the same reason it is difficult to detect their presence by chemical means, and lack of odour enhances the insidious nature of the compounds. It may be added that no enzyme system has been found which is inhibited to any extent by methyl fluoroacetate.

Derivatives of Fluoroethyl Alcohol

The hitherto undescribed fluoroacetaldehyde was obtained[8] with difficulty and in small yield by oxidizing fluoroethyl alcohol with manganese dioxide and sulphuric acid. The aldehyde, a liquid which polymerized on standing, produced, as was expected, a toxic action similar to that of the alcohol.

1-Fluoro-2-chloroethane, FCH_2CH_2Cl, obtained by the action of thionyl chloride on fluoroethyl alcohol, is an interesting compound in that the chlorine is unreactive to many reagents, and the substance is also non-toxic. It reacted[9], however, with sodium phenate giving phenyl 2-fluoroethyl ether, $C_6H_5OCH_2CH_2F$, which proved to be considerably less toxic than methyl fluoroacetate.

The bromine atom in fluorobromoethane was also found to be rather unreactive towards several reagents, but it would react with potassium thiocyanate to give fluoroethyl thiocyanate. The latter compound was a very useful starting-point for the preparation of many sulphur-containing fluorine compounds, for on treatment with chlorine water it readily gave fluoroethyl sulphonyl chloride, $FCH_2CH_2SO_2Cl$ (non-toxic)[10]. Of the other interesting derivatives of fluoroethyl alcohol may be mentioned di-(2-fluoroethyl)-sulphate, $(FCH_2CH_2O)_2SO_2$, which was found to be useful as a fluoroethylating agent. For example, fluoroethyl naphthyl ether was prepared by the action of di-(2-fluoroethyl)sulphate on an alkaline solution of β-naphthol.

By May 1943[4] we had come to the conclusion that "the FCH_2-group (in comparison with the $FCH<$ and $FC—$ groups) is particularly important in producing toxic action. Furthermore the FCH_2-group should be attached to a group such as —COOH or one of its derivatives. The 2-fluoroethyl group, $FCH_2CH_2—$, is also of great importance provided that the correct grouping is attached (e.g., FCH_2CH_2OH is toxic whereas FCH_2CH_2Cl is not)."

2-Fluoroethyl Fluoroacetate

In view of the fact that fluoroethyl alcohol produced a toxic effect comparable with that of fluoroacetic acid, it seemed worth while synthesizing a compound, in which the 'active' parts of these molecules were combined, in the hope of obtaining a substance of increased potency. In April 1943 we prepared[11] 2-fluoroethyl fluoroacetate, $FCH_2COOCH_2CH_2F$, by the action of fluoroacetyl chloride on fluoroethyl alcohol. In accordance with our expectations, the compound was found to possess greatly enhanced toxic properties, and it was shown that a 10-min. exposure to 0·092 gm./m.^{3} killed 70 per cent of a batch of rabbits, guinea pigs and rats. The L.C. 50 for rabbits by inhalation was 0·05 gm./m.^{3}. In short, the compound was about twice as toxic as methyl fluoroacetate (weight for weight). In addition it possessed an extremely faint odour.

The following related esters were prepared and their toxicities examined[4]:

Ester	Formula	Rough comparison of toxicity (inhalation) compared with methyl fluoroacetate
Ethyl fluoroacetate	$FCH_2COOCH_2CH_3$	Comparable
2-Chloroethyl fluoroacetate	$FCH_2COOCH_2CH_2Cl$	Rather higher
2-Fluoroethyl acetate	$CH_3COOCH_2CH_2F$	Less
2-Fluoroethyl chloroacetate	$ClCH_2COOCH_2CH_2F$	Rather higher
2-Fluoroethyl fluoroacetate	$FCH_2COOCH_2CH_2F$	Twice

Whereas 2-chloroethyl fluoroacetate was more toxic than methyl fluoroacetate, the sulphur analogue, namely, $FCH_2COSCH_2CH_2Cl$, was found to be considerably less toxic than the methyl compound.

The properties of the fluorine analogue, $FCH_2CH_2SCH_2CH_2SCH_2CH_2F$, of sesqui-*H* (2 : 2′-dichloroethyl ethylene dithioglycol) had for many years remained a matter of speculation, for all attempts to prepare this compound had failed. Sesqui-*H*, a compound of considerable interest, is a strong vesicant. In November 1943 we succeeded in preparing 2 : 2′-difluoroethyl ethylene dithioglycol as follows[12]:

$$FCH_2CH_2Br + NaSH \longrightarrow FCH_2CH_2SH \longrightarrow FCH_2CH_2SNa$$

$$FCH_2CH_2SNa + FCH_2CH_2Br + NaSCH_2CH_2F \longrightarrow FCH_2CH_2SCH_2CH_2SCH_2CH_2F.$$

The above reaction is rather remarkable in view of the unreactivity of the halogen atoms in fluorobromoethane towards the majority of reagents. In order to establish the identity of sesqui-fluoro-*H*, it was synthesized (in small yield) as follows:

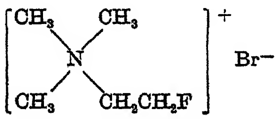
$$FCH_2CH_2Br + HSCH_2CH_2SH + BrCH_2CH_2F \xrightarrow{NaOH} FCH_2CH_2SCH_2CH_2SCH_2CH_2F.$$

Sesqui-fluoro-*H* is a mobile liquid, devoid of vesicant properties, and non-toxic. This lack of toxicity is understandable as the animal body is probably unable to rupture this C—S link, and hence the compound cannot easily give rise to fluoroacetic acid.

Fluorine-containing Ammonium Salts

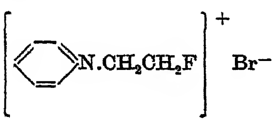
In view of the fact that amino-compounds often have marked physiological action, it seemed worth while preparing compounds containing both fluorine and a quaternary amino-grouping.

Advantage was taken of the fact that of the two halogens in fluorobromoethane, FCH_2CH_2Br, the bromine atom is the more reactive. When, for example, trimethylamine and fluorobromoethane were allowed to react at room temperature, addition took place and 2-fluoroethyl trimethyl ammonium bromide was produced[13].

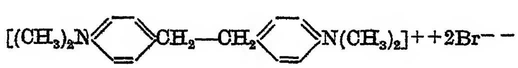


Triethylamine gave the corresponding compound on being heated with fluorobromoethane.

Pyridine gave 2-fluoroethyl pyridinium bromide on being refluxed with fluorobromoethane.



Dimethylaniline did not give the expected 2-fluoroethyl dimethylphenyl bromide, but gave in small yield the compound



the point of attack being the *para*-hydrogen atoms of the dimethylaniline. This was rather unexpected in view of the unreactivity of the fluorine atom in fluorobromoethane.

These fluoro-quaternary bromides proved to be not very toxic. The triethyl ammonium compound, for example, had an L.D. 50 for subcutaneous injection into mice of about 300 mgm./kilo. The low toxicity of these compounds may again provide useful evidence regarding their probable fate in the body. It seems that the bond connecting the 2-fluoroethyl group with the rest of the molecule is not readily ruptured. In this connexion, however, the possibility of an increase in the lability of the fluorine atom in these less toxic compounds must not be overlooked.

The study of these fluorine-containing salts was then extended, and we prepared two new compounds in this series, namely, 2-fluoroethyl glycine hydrochloride and 2-fluoroethyl betaine hydrochloride (that is, carbo-fluoroethoxy-methyl trimethyl ammonium chloride). The first of these was readily prepared by the Fischer–Speier esterification of glycine with fluoroethyl alcohol:

$$NH_2CH_2COOH + FCH_2CH_2OH \longrightarrow [NH_3CH_2COOCH_2CH_2F]^+ \; Cl^-.$$

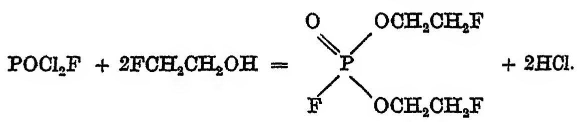
Using similar conditions with betaine and fluoroethyl alcohol, none of the expected ester was obtained, the betaine remaining unchanged. The reaction between anhydrous trimethylamine and fluoroethyl chloroacetate, however, gave fluoroethyl betaine hydrochloride in excellent yield.

$$NMe_3 + ClCH_2COOCH_2CH_2F \longrightarrow [Me_3NCH_2COOCH_2CH_2F]^+ \; Cl^-.$$

The 2-fluoroethyl glycine hydrochloride was found to have an L.D. 50 of approximately 10 mgm./kilo by subcutaneous injection into mice. The corresponding figure for 2-fluoroethyl betaine hydrochloride was 45 mgm./kilo.

Other Compounds

Finally, of the many 'fluoroacetates' prepared in this laboratory and too numerous to mention here, reference may be made to three compounds of peculiar interest. *Fluoroaspirin*[9] (*fluoroacetyl salicylic acid*) caused initial stupor without convulsions in mice. *Di-2-fluoroethyl fluorophosphonate* was prepared with the idea of combining the 'toxic principles' of the fluoroacetates and of the fluorophosphonates. It was readily obtained by the action of phosphorus oxydichlorofluoride on fluoroethyl alcohol[14]



The compound did indeed cause miosis, but the toxicity was rather lower than anticipated. At a concentration of 0·5 gm./m.^{3} (10 min. exposure) it did, however, produce in two out of six rats a remarkable state of hyperactivity followed by convulsions of an unusual type leading to coma and death.

Triethyl lead fluoroacetate, $FCH_2COOPb(C_2H_5)_3$. A systematic study of the sternutatory properties of organo-lead salts has been carried out in this laboratory and an account of these compounds will be given later. Triethyl lead fluoroacetate[9] is a most interesting compound in that it effectively combined the sternutatory properties associated with the trialkyl lead salts on one hand and (by injection) the convulsant action of the fluoroacetates on the other hand.

Summary

A large number of compounds described collectively as 'fluoroacetates' have been prepared and their physiological action examined at Cambridge. Provided that the correct groupings are present, they are highly toxic materials (by inhalation, injection, and to some extent by skin absorption) and may be described as convulsant poisons with a delayed action. With regard to the range of compounds

described in the present communication, it is to be noted that this toxic action is shown by those compounds which can give rise either by hydrolysis or oxidation to fluoroacetic acid[15]. Thus, for example, methyl fluoroacetate, ethyl fluoroacetate, fluoroacetamide and fluoroethyl alcohol are highly toxic. On the other hand, methyl α-fluoropropionate, $CH_3CHFCOOCH_3$, and methyl α-fluoro*iso*butyrate, $(CH_3)_2CFCOOCH_3$, are found to be non-toxic. Similarly fluorochloroethane, FCH_2CH_2Cl, and fluoroethane sulphonyl chloride, $FCH_2CH_2SO_2Cl$, are devoid of toxic action. The absence of typical 'fluoroacetate-like' convulsions when such compounds are injected into animals may well provide useful information regarding the ability of the animal body to break certain types of links; for example, the C—S link in fluoroethane sulphonyl chloride is presumably not very easily broken.

Whereas FCH_2COCl is highly toxic, $ClCH_2COF$ is not. Other examples show that the $-COF$ group (which gives rise to hydrofluoric acid) does not confer toxicity on the molecule.

A compound of outstanding interest is 2-fluoroethyl fluoroacetate, $FCH_2COOCH_2CH_2F$, which is twice as toxic as methyl fluoroacetate, weight for weight.

The fluorine atom in the FCH_2-group in the majority of these compounds is firmly bound, thus rendering decontamination extremely difficult.

We are indebted to the Director-General of Scientific Research (Defence) for permission to publish this report. We are very grateful to Mr. Davidson Pratt for the interest that he has shown in the work, and to the staffs of the Chemical Defence Research Department, Ministry of Supply in London, Sutton Oak and Porton, with whom we have maintained close contact during the War.

The following have taken part in these investigations at Cambridge:

H. McCombie; B. C. Saunders.

F. J. Buckle.	G. J. Stacey.
N. B. Chapman.	F. E. Smith.
H. G. Cook.	F. Wild (part-time).
R. Heap.	I. G. E. Wilding.
J. D. Ilett.	S. J. Woodcock.
F. L. M. Pattison.	

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[2] McCombie, H., Saunders, B. C., Briscoe, H. V. A., and Emeleus, H. J., Report to Ministry of Supply (Dec. 11, 1942).

[3] XZ Reports from the Cambridge Physiological Laboratory to Ministry of Supply, Nov. 14 onwards (particularly XZ 120, 124, 129, 131, 144, 145, 152).

[4] McCombie, H., and Saunders, B. C., Report No. 5 on Fluoroacetates to Ministry of Supply (May 30, 1943).

[5] McCombie, H., and Saunders, B. C., Report No. 2 on Fluoroacetates to Ministry of Supply (Feb. 17, 1943).

[6] Swarts, *Chem. Cent.*, 1, 1551 (1914).

[7] McCombie, H., and Saunders, B. C., Report No. 3 on Fluoroacetates to Ministry of Supply (March 31, 1943).

[8] McCombie, H., and Saunders, B. C., Report No. 12 on Fluoroacetates to Ministry of Supply (Nov. 10, 1944).

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[10] McCombie, H., and Saunders, B. C., Report No. 7 on Fluoroacetates to Ministry of Supply (Nov. 10, 1943).

[11] McCombie, H., and Saunders, B. C., Report No. 4 on Fluoroacetates to Ministry of Supply (April 15, 1943).

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[13] McCombie, H., and Saunders, B. C., Report No. 9 on Fluoroacetates to Ministry of Supply (Jan. 1, 1944).

[14] McCombie, H., and Saunders, B. C., Report No. 10 on Fluorophosphonates to Ministry of Supply (May 22, 1943).

[15] Carpenter, K. J., Kilby, B. A., McCombie, H., and Saunders, B. C., Report XZ 145, to Ministry of Supply (Jan. 8, 1944).

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

THE forty-fourth annual report of the Carnegie Trust for the Universities of Scotland for the year 1944–45 states that the executive committee has decided to continue the interim method of distribution of grants to universities and extra-mural institutions on an annual basis for 1945–46 and possibly longer, until the universities and other institutions are better able to assess the nature and extent of their post-war requirements and to indicate how the Trust can assist in meeting these needs to the best advantage, having regard to grants from Government and other sources for general or specific purposes which may be forthcoming.

In quantity, the volume of research undertaken has been much less than before the War, but the Trust advisers judge that there is no falling off in quality, and during the year there were indications that many of the fellows and scholars who have been on national service were anxious to resume the advanced studies which they had, temporarily, to abandon. Funds set aside for this purpose have accumulated to the extent of £17,043. In large measure the teaching fellowships are still being held in suspense awaiting the return of the holders to their academic posts, and a reserve amounting to £14,335 has been accumulating during the war years for payment of half the annual salaries of lecturers or assistants nominated by the universities.

A progressive decline in the numbers of beneficiaries under the Assistance to Students Scheme during the war years was arrested in 1944–45, disbursements of £52,225 being made to 3,073 students; all the evidence points to more severe demand on the Clause B resources of the Trust in the near future. On the other hand, during the year the Trust received by repayment £5,169 from 94 former beneficiaries. Revenue collected from all sources amounted to £142,147, and as in the previous year about 29 per cent of this sum was devoted to grants to universities and extra-mural institutions. Research awards fell to 8 per cent, while assistance to students with their class fees increased to nearly 37 per cent. Administration worked out at 4 per cent, and the remaining 22 per cent represents the surpluses for the year under Clauses A and B of the trust deed, together with the interest earned on the several reserve funds.

The report appended upon the work of investigators under the research schemes during the year refers to Mr. D. S. Falconer's work on the behaviour of wireworms of the genus *Agriotes*, Dr. Malcolm Wilson's work with Dr. Mary Nobel and Miss Elizabeth Gray leading to a paper on the blind-seed disease of rye-grass and its causal fungus, in which important suggestions are made for the control of the fungus by chemical treatment of foundation seed stocks, growing these in drills, and the maintenance of the general health of the stock, as well as to Miss P. J. Watson's work on "The Altitudinal Distribution of Variation in Festuca". Dr. J. Norman Davidson continued biochemical research in tissue growth. Mr. James Forrest completed an investigation into the oxidation of diphenylamine derivatives, and further advanced his work on syntheses in the fluoranthrene series. Mention is again made of brilliant work by Dr. Hwan-Wu Peng into the quantum theory of fields. A list of publications by fellows, scholars and recipients of grants received

since September 30, 1944, is appended, and also of awards of fellowships, scholarships and grants under the Research Scheme for the academic year 1945–46.

The report includes the report of the Superintendent of the Laboratory of the Royal College of Physicians for the academic year 1944–45, in which reference is made to further work under Dr. W. O. Kermack on the synthesis of bases of possible use as antimalarial drugs, including work on phenanthrolines and acridiminazole compounds, as well as on the synthesis of pyridoacridine derivatives. Chemotherapeutic research on corneal infections in rabbits continued.

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR 1945

THE report of the Director of Research of the Wool Industries Research Association for 1945, in addition to accounts of progress in the research programme during the past year, includes a review of war work, to which reference has previously been made only in general terms (The Association, Leeds 6). The most considerable of this was in devising and manufacturing special types of protective clothing. Two methods of impregnating cloth with carbon and fixing the carbon were developed into large-scale processes. In the first, a two-stage process, the carbon-impregnated cloth was sprayed with 'Positex', a rubber latex to which a positive charge had been given by substances of the cationic detergent type. In the second, a one-bath process, the carbon rubber latex mixture was stabilized by methylcellulose. Carbon-impregnated cloth was used extensively to trap the odour from stinking wounds, and the use of carbon (medical filter) cloth in hospitals for various purposes is likely to continue. As a member of the Ministry of Supply Textile Rotproofing Panel, the Association helps to develop and apply large-scale methods of tropical proofing. Socks, jerseys and blankets were rot-proofed by impregnation with 1 per cent of chromium (as potassium dichromate), and as the soluble chromium was restricted to 0·01 per cent the dyeing technique had to be modified. All-wool and wool-mixture felts used as internal components and packing for ammunition and wireless gear have been proofed with cuprammonium sulphate against attack by moths and bacteria, and a khaki fleece cloth was designed and manufactured at Torridon in response to a request for a special fabric for anti-aircraft personnel. The Association has also made an exhaustive test of proprietary substitutes for olive oil in large-scale combing of wool, and five of these, together with a 'Control Combing Oil' devised by the Association, based on ground-nut oil, by early 1940, have been used throughout the War.

Reference is also made in this report to developments arising out of the success of the Association's dry chlorination process to prevent shrinkage, and the greatly increased demand for shrinkage-resistant garments by the Forces. To meet the new situation, the Association took out on behalf of the Ministry of Supply a second certification mark, 'Warnorm', which had to be applied to all Service underwear which had been rendered unshrinkable by an approved finisher. Such finishers were firms who had installed methods of test and tested their products systematically during treatment. These firms were inspected by the staff of the Association, and if necessary instructed in testing methods and the recording of results, while their products were also tested by the Association. Later, the shrinkage resistance of serge coats worn in shell-filling factories was also specified under the 'Warnorm' scheme, while the papain process was used to make unshrinkable cheeses of yarn used for underwear worn by the A.T.S.; Land Army hose, sea-boot stockings, R.A.F. socks and jungle-green pullovers also came under the scheme.

Investigations during the past year referred to in the report include those on the physical properties of wool, including studies on moisture relations and mechanical properties, which suggest that whether or not a molecule penetrates a fibre depends on the difference in free energy of the molecule in the fibre and that of the molecule in the vapour. A review of the properties of commercially available plastics indicates that there is at present little prospect of making the elasticity of synthetic fibres as great as that of wool by coating them with plastics. Precision measurements on felt indicate that the thermal conductivity of the wool fibre is seven times that of air and only one quarter of the comparable value for cotton. Chemical investigation of the keratin structure suggests that at least four distinct types of sulphur linkage must be postulated; while in biochemical investigations on the same problem, the methods of analysis already developed have now been supplemented by an electrical method of separation known as ionophoresis and used to identify the short lengths of the amino-acid chain into which keratin is broken up by partial hydrolysis.

Processing research has shown the possibility of reducing the large number of operations in worsted drawing and the importance of atmospheric humidity in drawing level yarns. An investigation completed for the Australian Council for Scientific and Industrial Research has shown that the steely fleeces of Merinos produced on a diet deficient in copper could be corrected by supplementing the copper. The effect was less marked with Border Leicester fleeces. Careful analyses of the results of the seasonal growth and character of wool in the Romney flock maintained at Cambridge suggest that summer growth would occur in the winter if nutrition was sufficiently good. A review of the work of the Technical Departments stresses the continued attention given to questions involved in the 'tropic-proofing' of woollen goods, the dyeing of chlorinated wool, the effect of chlorination on the change in shade of dyed wool, and on bloom dips. Wearing trials on half-hose are being made to determine the relative amounts of shrinkage occurring during wearing and washing, the best methods of making wearing tests, and the relation between the standards of shrinkage laid down in various specifications and actual wearing conditions.

The need for closer contact between manufacturers and finishers in Scotland of both hosiery and woven materials has led to the formation of a branch at Galashiels, while a Hosiery Research Committee, representative of manufacturers and finishers in both the Midlands, Scotland and the rest of England and Wales, has been instituted. In February 1945 the Director of Research was invited by the Australian Government to visit Australia to advise the Council for Scientific and Industrial Research on the lines of research which should be undertaken to assist the wool industries and the organisation required. The

Director left Leeds in April, spending three months in Australia, three weeks in New Zealand and four weeks in the United States and Canada, returning in October. The Australian Government in 1945 passed the Wool Use Promotion Act, which made available a sum of £600,000 for the promotion of the wool industries and for research in that field (see *Nature*, July 13, p. 70). In New Zealand the question of internal co-ordination and external collaboration was in the forefront, and a considerable increase in research both on the production and manufacture of wool is confidently expected in both countries.

Referring to the financial position of the Association and negotiations still in progress for a statutory levy, the report notes the recommendation of the British Wool Federation that the whole of the levy for research should be calculated on imported wool as avoiding questions of equitable distribution arising.

THE ANCIENT *OIKOUMENÊ* AS AN HISTORIC CULTURE AGGREGATE

In his Huxley Lecture for 1945 before the Royal Anthropological Institute, the eminent American anthropologist, Dr. A. L. Kroeber, put forward an interesting hypothesis concerning the origin and diffusion of the more important cultures (The Institute, 2*s*. 6*d*.). The Greek word *oikoumenê*, 'the inhabited', referred to what they thought of as the whole habitable world—that from the Pillars of Hercules to what the Indians called the Seres—a belief which is naturally no longer tenable. But the fact remains that this tract does still correspond to a great historic unit, and if the term is shifted to mean the range of man's most developed cultures, then we have a convenient designation for a set of related happenings and products of significance to both historian and ethnologist.

There is an interesting sequence, for example, in the history of sculpture. In its early stages there was prolonged, but intermittent, activity for two millennia around the eastern Mediterranean from Egypt to Mesopotamia. About 600 B.C. this collapsed, and Greek sculpture replaced it to the west and Persian to the east; after a period of great artistic productivity again the centres shifted, one to the east, the other westward to Rome, and so on. It is a point worthy of note that each new focus was peripheral; that is, the seed flourished on new and fertile soil, not on that which was played out.

In another and different sphere, that of culture, the Islamic growth affords food for thought. This religion shows great unity and uniformity in spite of its vast spread, possessing as it does a universal church and a universal language, both written and spoken in the form of Arabic. It sprang into being, in the person of Mohammed, among the downtrodden Arabs of the Near East who had had imposed upon them presumably uncongenial civilizations from Greece and Iran, and it gave its adherents the opportunity to throw off the Helenic, Sassanian and Christian yokes. The impetus carried Islam from Iran and Irak through Syria and Egypt to Spain, and eastward to India and the East Indies, and the secret of its success lies probably in the fact that it reduced and simplified culture, bringing it within the grasp of the overworked and worn out 'heart area' of an older civilization.

So, too, with other cultures, both material and ceremonial, which seem to have started in this same area and spread north, south, east and west, with, of course, modifications to suit the varied conditions. In fact, the *oikoumenê* may be defined as a great wealth of culture growth, areally extensive and rich in content. Within this web new cultural materials have tended to spread from end to end with more or less rapidity. Our *oikoumenê*, like that of the ancients, has its limits; Europe and Asia and the main portion of Africa lie within it, though its relations with the farthest portion, South Africa, have been irregular and retarded. Australia may be omitted from it, but Oceania in general shows impacts of its culture. Taken as a whole, American culture has developed independently of *oikoumenê*, its own 'heart' being in the tract from Central Mexico to Peru. Northern north America has obviously received impacts from Asia, but these have not influenced the main culture stream.

K. RISHBETH

FORTHCOMING EVENTS

Tuesday, September 17—Thursday, September 19

SOCIETY FOR APPLIED BACTERIOLOGY (at the University, Glasgow).—Annual General Meeting and Paper Reading Conference.

Wednesday, September 18

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (in the Board Room, Elite Cinema, Parliament Street, Nottingham), at 7 p.m.—Mr. L. C. Mitchell: "Dyeing of Milanese and Locknit, with special reference to Cellulose Acetate".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Hull (September 20).

ASSISTANT LECTURERS (2) IN CHEMISTRY (Organic, Inorganic or Physical)—The Registrar, University College, Hull (September 21).

ASSISTANT LECTURER IN ZOOLOGY—The Secretary, King's College, Strand, London, W.C.2 (September 23).

SENIOR and JUNIOR DIETITIANS in the Scientific Adviser's Division of the Ministry of Food—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.4631 (September 27).

LECTURER IN THE DEPARTMENT OF CHEMISTRY, Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (September 28).

LECTURER IN ENGINEERING—The Secretary, The University, Aberdeen (September 28).

RESEARCH ASSISTANT for work on flow of fluids in porous materials, with particular reference to land drainage—The Secretary, School of Agriculture, Cambridge (September 30).

DIRECTOR OF SAFETY IN MINES RESEARCH—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting C.513 (September 30).

DIRECTOR OF RESEARCH for the conduct of research on all aspects of prevention and extinction of fire, the safety of life in fire and mitigation of damage—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1620 (September 30).

MYCOLOGIST at the Tea Research Institute of Ceylon, St. Coombs, Talawakelle—The Secretary, Ceylon Association in London, King William Street House, Arthur Street, London, E.C.4 (September 30).

LECTURER IN MATHEMATICS in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 30).

CHAIR OF FUEL TECHNOLOGY—The Registrar, The University, Sheffield (October 1).

DIRECTOR OF METEOROLOGY, Government of Burma—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (October 3).

TEACHER (full-time) OF STRUCTURAL ENGINEERING at the Brixton School of Building, Ferndale Road, London, S.W.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (October 5).

LECTURERS IN MATHEMATICS, PHYSICS, BOTANY and GEOLOGY, at the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 18).

LECTURER IN PHYSICS at the Wolverhampton and Staffordshire Technical College—The Clerk to the Governors, Education Offices, North Street, Wolverhampton.

METEOROLOGISTS for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Meteorologist'.

LABORATORY TECHNICIAN for the Veterinary Department, Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.16836.

LABORATORY STEWARDS in the Engineering and Pure Science Departments of the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough.

PHYSICIST as head of the General Physics section of the Physics Department—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

INSPECTORS (4) OF AGRICULTURE for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Inspector of Agriculture'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Health. Reports on Public Health and Medical Subjects, No. 93: A Report on the Re-adjustment in Civil Life of Soldiers discharged from the Army on Account of Neurosis. By Dr. Eric Guttman and Elsie L. Thomas. Pp. 72. (London: H.M. Stationery Office, 1946.) 1*s.* 3*d.* net. [84

Report on the Phenological Observations in the British Isles from December 1944 to October 1945. By Major H. C. Gunton. (No. 55.) (*Quarterly Journal of the Royal Meteorological Society*, Supplement to Vol. 72.) Pp. 43. (London: Royal Meteorological Society, 1946.) 3*s.* [84

Institute of Fuel. Report of the Council for the Year 1945. Pp. 12. (London: Institute of Fuel, 1946.) [84

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences), Vol. 62, Part 2, No. 20: Evaluation and Application of Certain Ladder-Type Networks. By W. E. Bruges. Pp. 175–186. (Edinburgh and London: Oliver and Boyd, 1946.) 2*s.* [84

Report of the Rugby School Natural History Society for the Year 1945. (Seventy-ninth issue.) Pp. 48. (Rugby: Rugby School, 1946.) [114

Imperial Institute. Annual Report, 1945, by the Director, Sir Harry Lindsay, to the Board of Governors. Pp. 74. (London: Imperial Institute, 1946.) [114

Imperial Cancer Research Fund. Forty-third Annual Report, 1945–1946. Pp. 42. (London: Imperial Cancer Research Fund, 1946.) [114

River Flow Records. By Capt. W. N. McClean. River Moriston at Invermoriston: Four Years ending September 30th, 1944. Pp. 12. River Garry at Invergarry: Eight Years ending September 30th, 1944. Pp. 21. River Lochy at Gairlochy: Nine Years ending September 30th, 1944. Pp. 29. (London: The Author, 39 Phillimore Gardens, W.8, 1945.) [114

Final Act and Convention of the International Overfishing Conference, London, 25th March–5th April 1946. (Miscellaneous No. 7, 1946.) (Cmd. 6791.) Pp. 12. (London: H. M. Stationery Office, 1946.) 2*d.* net. [154

Board of Trade. Patents and Designs Acts: Second Interim Report of the Departmental Committee (Cmd. 6789). Pp. 38. (London: H.M. Stationery Office, 1946.) 9*d.* net. [154

British Electrical and Allied Manufacturers' Association. Report of the Council for the Year 1945. Pp. 16. (London: British Electrical and Allied Manufacturers' Association, 1946.) [154

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City of Leicester Museum and Art Gallery. 40th Annual Report to the City Council, 1 April 1943 to 31 March 1944. Pp. 20 + 2 plates. 41st Annual Report to the City Council, 1 April 1944 to 31 March 1945. Pp. 24 + 4 plates. (Leicester: Leicester Museum and Art Gallery, 1945–1946.) [164

Memoirs of the Cotton Research Station, Trinidad. Series B, Physiology, No. 17: (1) Studies on Foliar Hydration in the Cotton Plant, vi. A Gel Theory of Cell Water Relations, by E. Phillis and T. G. Mason; (2) The Effect of Ringing and of Transpiration on Mineral Uptake—a Reply to Criticism, by T. G. Mason and E. Phillis; (3) Studies on the Partition of the Mineral Elements in the Cotton Plant, v. An Adsorption Theory of Nitrogen Regulation, by T. G. Mason and E. Phillis; (4) The Effect of Extreme Desiccation on the Viability of Cotton Seed, by E. Phillis and T. G. Mason. Pp. 297–360. (London: Empire Cotton Growing Corporation, 1946.) 2*s.* 6*d.* [174

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 188: A Soil, Land-Use, and Erosion Survey of part of County Victoria, South Australia, including the Hundreds of Belalie, Whyte, Reynolds, and Anne, and part of the Hundreds of Caltowie, Yangya, and Bundaleer. By C. G. Stephens, R. I. Herriot, R. G. Downes, T. Langford-Smith and Dr. A. M. Acock. Pp. 40. (Melbourne: Government Printer, 1945.) [53

Scientific Publications of the Cleveland Museum of Natural History. Vol. 4, No. 3: Birds of the White-Fuller Expedition to Kenya, East Africa. By Harry C. Oberholser. Pp. 43–122+15 plates. (Cleveland, Ohio: Cleveland Museum of Natural History, 1945.) [53

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 40: The Ammassalik Eskimo. In 2 Parts. Second Part, Second half-volume, No. 4: Social Customs and Mutual Aid. By William Thalbitzer. Pp. 569–740. 10 kr. Bd. 72, Nr. 2: The Silurian Faunas of North Greenland. (Jubilaeumsexpeditionen Nord om Grønland, 1920–23.) 2: The Fauna of the Offley Island Formation, Part 1: Coelenterata. By Chr. Poulsen. Pp. 28+6 plates. 2 kr. Bd. 72, Nr. 3: The Silurian Faunas of North Greenland. (Jubilaeums-expeditionen Nord om Grønland, 1920–23.) 2: The Fauna of the Offley Island Formation, Part 2: Brachiopoda. By Chr. Poulsen. Pp. 60+6 plates. 3.50 kr. Bd. 80, Nr. 6: Brachiopoda from the Waters West of Greenland. By Elise Wesenberg-Lund. (The Godthaab Expedition, 1928.) Pp. 24. 1.25 kr. Bd. 80, No. 7: Gastropoda Opisthobranchiata (excl. Pteropoda). By Henning Lemche. (The Godthaab Expedition, 1928.) Pp. 66. 3 kr. Bd. 80, Nr. 8: Siphonophora. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 24. 1 kr. Bd. 80, Nr. 9: Ctenophora. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 20. 1 kr. (København: C. A. Reitzels Forlag, 1940–1943.) [53

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 80, Nr. 10: Pelagic Tunicata. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 10. 0.50 kr. Bd. 81, Nr. 1: Medusae. By P. L. Kramp. (The Godthaab Expedition, 1928.) Pp. 168. 8 kr. Bd. 89, Nr. 1: Farms and Churches in the Mediaeval Norse Settlements of Greenland. (Researches into Norse Culture in Greenland.) By Aage Roussell. Appendix: The Osseous Material from Austmannadal and Tungmeralik, by Magnus Degerbøl. Pp. 356. 17 kr. Bd. 89, Nr. 2: The Mediaeval Norse Settlements in Greenland—Anthropological Investigations. (Researches into Norse Culture in Greenland.) By K. Fischer-Møller. Pp. 84+22 plates. 5 kr. Bd. 89, Nr. 3: The Mediaeval Norseman at Gardar—Anthropological Investigation. (Researches into Norse Culture in Greenland.) By K. Bröste and K. Fischer-Møller; with Dental Notes and a Chapter on the Dentition, by P. O. Pedersen. Pp. 62+30 plates. 4.50 kr. Bd. 90, Nr. 1: Inland Farms in the Norse East Settlement—Archaeological Investigations in Julianehaab District, Summer 1939. (Researches into Norse Culture in Greenland.) By Christen Leif Vebaek. Appendix: Animal Bones from Inland Farms in the East Settlement, by Magnus Degerbøl. Pp. 120. 5.50 kr. (København: C. A. Reitzels Forlag, 1941–1944.) [53

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 106, Nr. 1: Report on the Expedition. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) By C. C. A. Gabel-Jørgensen. Pp. 270. 13 kr. Bd. 107, Nr. 1: Magnetiske Maalinger udført paa Grønlands Sydvest–og Sydøstkyst. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) Af Johannes Olsen. Pp. 30. 1.25 kr. Bd. 107, Nr. 2: Tidal Observations made at Nanortalik and Julianehaab in 1932–1934. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) A: Works in Field, by C. C. A. Gabel-Jørgensen; B: Results from Tidal Observations made in South-Greenland, by J. Egedal. Pp. 48. 2.25 kr. Bd. 107, Nr. 3: Quaternary Geological Observations, etc., in South-East and South Greenland. (6 og 7 Thule-Expedition til Sydøstgrønland, 1931–33.) By Richard Bøgvad. Pp. 42. 2 kr. Bd. 110, Nr. 2: The Lower Jurassic Rocks of East Greenland. (Ekspeditioner til Scoresbysund Distriktet udført i aarene 1934 og 1936.) Part 2: The Mesozoic Sediments of the Kap Hope Area, Southern Liverpool Land. By Alfred Rosenkrantz. Pp. 56+4 plates. 3 kr. (København: C. A. Reitzels Forlag, 1940–1942.) [53

Forest Research in India and Burma, 1943–44. Part 1: The Forest Research Institute. Pp. 160. (Dehra Dun: Forest Research Institute, 1945.) 3 rupees; 5*s.* [63

Punjab Irrigation Research Institute. Research Publication, Vol. 4, No. 13: Percolation of Water through Soils. By A. G. Asghar and C. L. Dhawan. Pp. 8+7 plates. (Lahore: Government Printing Office, 1945.) 6 annas; 7*d.* [63

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 112, Nr. 5: Cyclolobus from the Permian of Eastern Greenland. (Geologisk Ekspedition til Østgrønland, 1936–38.) By A. K. Miller and W. M. Furnish. Pp. 8+1 plate. 0.50 kr. Bd. 113, Nr. 3: A Sedimentary Petrological Investigation of a Number of Sand Samples from the South Coast of Greenland between Unartok and Tokulinek. (Geologiske Undersøgelser i Sydøstgrønland.) By J. Vroman. Pp. 22+1 plate. 1 kr. Bd. 114, Nr. 3: Das devonische Faltungsbegiet Nördlich des Moskusoksefjordes in Ostgrönland. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von H. Butler. Pp. 32+10 plates. 2.50 kr. Bd. 114, Nr. 4: Der Postdevonische Bau Ostgronlands zwischen 73° und 75° N. Br. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von Andreas Vischer. Pp. 20. 0.75 kr. Bd. 114, Nr. 5: Stratigraphie des Küstengebietes von Ostgrönland zwischen 73° und 75° N. Lat. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von Wolf Maync. Pp. 34. 1.50 kr. Bd. 114, Nr. 6: Vorlaüfige Mitteilung über die Geologie des östlichen Scoresbylandes in Nordostgrönland. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von Wilhelm Bierther. Pp. 20+2 plates. 1.25 kr. Bd. 114, Nr. 7: Stratigraphisch-geologische Untersuchungen in der OstgrönlandischenSenkungszone des nördlichen Jamesonlandes. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von Hans Stauber. Pp. 34+2 plates. 2 kr. Bd. 114, Nr. 8: Die Kristallingebiete von Clavering–Ø und Payer Land (Ostgrönland). (Geologisk Ekspedition til Østgrønland, 1938–39.) Von A. E. Mittelholzer. Pp. 42+2 plates. 2.25 kr. Bd. 115, Nr. 1: Studien an Eruptivgesteinen aus Ostgrönland. (Geologisk Ekspedition til Østgrønland, 1936–38.) Von A. Rittmann. Pp. 156. 7 kr. (København: C. A. Reitzels Forlag, 1940–1942.) [63

Catalogues

The CINTEL Metal Detector. Pp. 4. (London: Cinema-Television, Ltd., 1946.)

Service to Science. No. 12. Pp. 4. (Croydon: Townson and Mercer, Ltd., 1946.)

Libros de Medicina. Pp. 96. (Madrid: Casas y Buendia, Conde Xiquena 17, 1946.)

Scientific Books many of them of Medical Interest. (Catalogue 83.) Pp. 36. (London: Ifan Kyrle Fletcher, 12 Lansdowne Road, S.W.20, 1946.)

Speetol-Gordon Inspection Equipment. Pp. 6. Speetol-Gordon Multiscope. Pp. 6. (London: Speed Tools, Ltd., 1946.)

Natural History, Books on Agriculture, Botany, Geology, Zoology, Meteorology, Forestry, Mineralogy, Entomology, Veterinary Science, etc. (Catalogue 85.) Pp. 36. (London: Ifan Kyrle Fletcher, 12 Lansdowne Road, S.W.20, 1946.)

The New 'P.G. 14', an All Glass Laboratory Filter Press, etc. Pp. 2. Glassblowers' Tools. Pp. 2. Ovens, Electric, etc. Pp. 2. Anhydric Incubators, Tube Furnaces, Shaking Machine. Pp. 2. Laboratory Stirrer, Melting Point Apparatus, etc. Pp. 2. (London: A. Gallenkamp and Co., Ltd., 1946.)

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FUTURE ORGANISATION OF SCIENTIFIC RESEARCH

IN giving the University Grants Committee new terms of reference, as announced by the Chancellor of the Exchequer in a written answer to a question in the House of Commons on July 30, the Government has taken a first step to implement the findings of the Barlow Committee. That Committee, while considering that the expansion programme envisaged did not call for the replacement of the University Grants Committee by any new organ of government, expressed the view that circumstances demanded that the University Grants Committee should increasingly concern itself with positive university policy and that it might be desirable for this purpose to revise its terms of reference and to strengthen its machinery. Under the new terms of reference, the University Grants Committee is now empowered, in addition to inquiring into the financial needs of university education and advising the Government as to the application of grants made by Parliament towards meeting them, "to collect, examine, and make available information on matters relating to University education at home and abroad; and to assist, in consultation with the Universities and other bodies concerned, the preparation and execution of such plans for the development of the Universities as may from time to time be required in order to ensure that they are fully adequate to national needs".

With the strengthening of the personnel of the Committee already announced, the Government has gone some way to meet a need which has been urged in successive reports from the Parliamentary and Scientific Committee, the British Association's Committee on Post-war University Education, the Association of Scientific Workers and the Association of University Teachers, as well as in Parliament itself. The responsibility for co-ordinating the development of the universities from the national point of view is placed fairly on the shoulders of the University Grants Committee. It may indeed be open to doubt whether that Committee, as at present constituted, can effectively discharge the duties as well as the responsibilities of a planning body. Sir Ernest Simon has argued that the membership of the Committee should be modified so as to include more members in touch with the national need for graduates in public life, in the professions, in industry and in commerce. Whether the University Grants Committee is to be the sole instrument for the maintenance of relations between the Government and the universities in the period of radical development immediately ahead, or whether it is to be assisted by a University Advisory Council or other central body established by the universities themselves to represent their co-ordinated views, it will be necessary to provide the Committee with an adequate secretariat. Without that the Committee cannot even start on its task of preparing and executing the much-needed development plans, and an early Government announcement on that point will indicate the measure of urgency with which the Government regards action

on the report of the Committee on Scientific Man-power.

It may well be that when the reconstituted University Grants Committee, equipped with an adequate secretariat, gets to work, it will consider first the man-power aspect of university development and attempt to arrive at a closer overall target figure for the student population than was given in the Barlow Report. Nevertheless, with that report in front of it, the Committee should scarcely need strengthening in the way that Sir Ernest Simon suggests to enable it to deal with the detailed quantitative planning of university expansion in accordance with the recommendations of the Barlow Report. What is much more important than experience outside the universities is the presence of members of wide university experience and sound judgment, capable of appreciating the difficulties and danger, as well as the possibilities, of university expansion, and of the standing that will command the respect and secure the co-operation of the university authorities. It is already clear that any programme of university expansion adequate to meet the needs of the nation in the next fifteen or thirty years will involve on the part of certain universities a much bigger effort than they appear at present either to contemplate or to be disposed to make.

Any strengthening of the University Grants Committee should for this reason look to the states-man-like qualities which will be required to win co-operation in such circumstances, and know-ledge of the universities from inside may be a far more important qualification than actual experience of many walks of life. The main value of the recon-stitution of the University Grants Committee two years ago to allow the association with it of persons not actively engaged in university life is that it permits such qualities of statesmanship to be sought for the Committee over the widest possible field. To plan the provision of an adequate supply of trained man-power and woman-power for the nation's needs and to secure the execution of an appropriate policy, with all that is involved in the determination of the right priorities and of securing the most effective use of that man-power and woman-power, will call for statesmanship of a high order. The Goodenough Report on Medical Schools observed that a com-munity that wished to promote research had to do two things: "First and foremost, it must find and train the men who have the ability and impulse for scientific inquiry. Secondly, it must create the most favourable conditions for their work and give them the tools they need." No two principles could form a better guide for the University Grants Committee in dealing with its new responsibilities.

Quantitatively the man-power situation and the expansion of the universities to provide teachers, buildings and equipment involved may be the more urgent and immediate task confronting the University Grants Committee. But in formulating its plans for long-term development the Committee may well be expected to probe for itself some of the assumptions and statements of both the Barlow Committee and the [illegible] Committee, which have been questioned, for example, by Sir Cyril Norwood and Mr. Kenneth Lindsay, as to the country's capacity to absorb a greatly increased number of graduates. That task in itself involves some attention to the country's needs of research as well as in other fields, and in respect of the former the Committee should derive considerable help from a report from the Royal Society on the "Needs of Research in Fundamental Science after the War", to which atten-tion was directed at the recent Empire Scientific Conference.

This report is based on the reports of a number of committees appointed or invited to consider post-war needs as a sequel to a letter from Sir Ralph Fowler and Prof. P. M. S. Blackett in October 1943, directing attention to the danger that development in funda-mental physics might be relatively neglected in comparison with applied physics, the development of which is now being actively pursued by various bodies. In urging the Council of the Royal Society to set up a committee to consider the post-war needs of fundamental research in physics, they suggested that the development of fundamental physics in Great Britain could no longer be left entirely to the local initiative of the universities, but that some central guidance on major matters of policy was essential if the case for increased resources was to be put adequately before the relevant government authorities. It was realized that the universities would be making their individual claims to the University Grants Committee, but nevertheless it was highly desirable to present the claims of the fundamental sciences from the point of view of the advance of research on a national scale. Moreover, the welfare of research in the universities has become a national interest, and its support should be on such a scale as to ensure that the scientific departments of the universities are free to devote themselves to the search for new knowledge and to the training of students in the sciences and in methods of research.

Accordingly the Council of the Royal Society set up on November 30, 1943, a committee for post-war fundamental research in physics, and later other committees for chemistry, for biology and bio-chemistry, for geology, for geophysics and for geography. The Gassiot Committee was charged with the duty of considering the needs of meteorological research, while oceanography was covered by the report of a sub-committee of the National Com-mittee for Geodesy and Geophysics. Of subjects commonly included in the medical group, only bio-chemistry is covered in this report; research in physiology, anatomy, pathology and medicine was not specially reviewed, partly on account of the support already given by the Medical Research Council, and partly because the needs of these sub-jects have been considered in the Goodenough Report on Medical Schools. For a like reason the needs of research in agriculture and engineering are not dealt with, government support in those fields being regarded as primarily the concern of the Agricultural Research Council and the Department of Scientific and Industrial Research.

With those exceptions, this report of the Royal Society represents an attempt to survey the broad field of fundamental research in the way that has been repeatedly advocated in recent years, with the view of seeing that no important field is neglected and that some concerted effort is made to secure that the advancing front of science is more evenly balanced and without gaps. In this survey distinction is drawn, moreover, between 'ordinary' expenditure involved in the normal running of a research laboratory, including all expenses which would ordinarily be met out of departmental funds and grants (including maintenance grants) to students, and 'extraordinary' expenditure such as that involved in the purchase or construction of special items of apparatus or equipment, erection of special buildings or acquisition of special staff necessitated by specially important or expensive fields of work in particular centres or by unexpected developments in research for which no budget would have been possible. These two categories are discussed separately in the report, and recommendations are made under both headings.

Dealing first with ordinary expenditure, the Council of the Royal Society regards maintenance grants to students in training for research, grants for laboratory staff, and general equipment, etc., as the special concern of the universities; but it is convinced that there should be available a very substantial increase in the number of maintenance grants allotted to students for training in research, and suggests that the whole question of the administration of such grants should be reviewed. The Council would favour a scheme by which the University Grants Committee included in each block grant allotted to a university an earmarked sum sufficient to cover the needs of the different scientific departments within that university for maintenance grants for students in training in research, machinery being created within the university for the allocation of grants to the students in the several scientific departments. A similar arrangement is favoured in regard to the normal costs of research in the various departments, and in this connexion, while the Council has not specifically studied such questions as the desirable increase in academic staff, the extension of buildings or the financial provision for meeting standing expenses of university scientific departments, it attaches much importance to more ample provision for the payment of adequate laboratory staff and special technical assistants, and especially to an increase in the number of combined teaching and research posts so as to provide teachers with time for research and to enable them to give due attention to those in training for research.

The Council estimates that, excluding mathematics, engineering, medicine and the medical sciences—the social sciences are not mentioned in the report—the normal ordinary expenditure which will be required for maintenance grants to students in training in research, grants to senior research workers, costs of research equipment and materials, and of laboratory staff, technical assistants and mechanics will amount to about one million pounds per annum. Of this, £300,000 is for physics, £400,000 for chemistry, £75,000 for geology, and £225,000 for biology and biochemistry, while for geophysics and meteorology an additional grant of between £15,000 and £20,000 per annum is required.

A few other points of detail deserve to be noted in the Council's discussion of the various committees' reports in relation to ordinary expenditure. A figure of £225 per annum is adopted as a reasonable average maintenance grant for a student living away from home, while for senior research workers the committees agreed in recommending that the value of such grants should be between £400 and £600 a year, the Council urging that the main financial support for these grants should be on a national scale, with a total number of grants about twice that provided in a pre-war year, or about 300–350 awards. Again, the Council endorses the recommendation of the committees that the increase in senior personnel engaged on fundamental research in universities should be effected mainly by increasing the number of teaching posts giving adequate time for research, as well as the general desire of the committees for the provision of more technical assistants of the trained specialist type and also of the more general laboratory assistants, better workshop equipment and more laboratory mechanics. On such tactical matters bearing on the more efficient use of trained research workers the Council is far more alert than the Committee on Scientific Man-power, the report of which passed over the importance of this aspect, the opportunity which is presented in the release of technical staff from the Forces, or the value of providing centres of training for such laboratory staff.

Passing now to 'extraordinary' expenditure, the Council concludes that such needs should be met by grants made by the Treasury on the advice of the Royal Society for sums over £2,000, and for smaller sums by very substantially augmenting the Parliamentary Grant in aid of Scientific Investigations administered by the Royal Society. As much flexibility as possible should be introduced into the system of administration so that demands can be met at any time without undue delay. The larger grants direct from the Treasury are intended to provide new institutions, or large and expensive equipment, and the staff required for such equipment, or to meet the expenses of special new projects or expeditions. The report points out that it is often on the borderlines between the sciences, such as biochemistry, that most activity occurs, and from time to time demands arise for special departments, laboratories or institutes to develop certain fields of activity. Another example is oceanography, where a National Oceanographical Institute is needed, establishment of which at Liverpool is recommended by the sub-committee.

Some permanent organisation to consider the requirements for fundamental research in biology, as well as a research institute for ecological studies and the establishment of an institute of general microbiology which should be the focal point for microbiological research in the Empire, and the establishment of a Meteorological Research Institute, are among the concrete proposals from the committees;

and the reports from those considering the needs of biology, geophysics, geology and meteorology give more precise indication of the specific subjects requiring fundamental investigations than those from the remaining committees. Again it is pointed out that there is at present in Great Britain no properly equipped laboratory devoted to biophysical research. The Council, however, considers that in general the systematic converging attack on a single problem by several branches of science which in some countries is conducted in special research institutes would here be more economically accomplished through the close contact of, and freedom of movement within, the existing university laboratories and research institutions. While some indication is given of the requirements in this category—the International Seismological Summary is instanced as one example requiring Treasury assistance—it is considered impossible to state them precisely. The needs are likely to be unusually great during the first few years after the War, when many new projects must be started if Great Britain is to regain its position in the van of scientific progress.

The Council recommends that the annual government grant for scientific investigations should be at least three times its pre-war size, or about £20,000 to £25,000 per annum. This grant should be used to initiate and further specially promising researches, to assist scientific expeditions and collections, or for any purpose or means which helps the progress of research in the fundamental sciences. Besides this it is anticipated that government departments and scientific establishments will continue the collaboration and assistance in the prosecution of special scientific researches which have proved so valuable in the past. The Council also endorses a recommendation from one of the committees regarding the allocation of scientific instruments and equipment from surplus government stocks after the War as an immediate assistance to research, in the placing of which the Royal Society could assist.

Here the report is concerned with matters of tactics rather than of strategy, and in its remaining recommendations the Council deals with a number of questions in that field to which the Empire Scientific Conference also devoted some attention. The Council considers, for example, that there is great need for a travel fund to enable scientific research workers to go from one centre of research to another in order to further their work, and to provide closer scientific collaboration, particularly within the Empire. For this purpose a sum of at least £15,000 per annum is desirable.

In accordance with the specific recommendation of the Council of the Royal Society, this matter, which has been frequently discussed in a number of other reports in recent years, was fully considered at the Empire Scientific Conference. Contributions, in which not merely the interchange of scientific workers but also the value of the scientific liaison officers established during the War are discussed, were received from Dr. W. M. Hamilton of New Zealand, Dr. B. F. J. Schonland of South Africa, and from Sir S. S. Bhatnagar, Sir J. C. Ghosh and Prof. P. C. Mahalanobis. While very little that was new emerged from the deliberations of the Conference on this subject, thought was clarified and the way cleared for action in a matter of the utmost importance if economy of effort is to be secured and the most efficient use made of the limited resources of scientific man-power of the British Commonwealth. Dr. Schonland, who gave a concise statement on existing travel grants and facilities for visits by scientific officers in South Africa, indicated the specific needs which require examination, while the New Zealand and Indian delegates were concerned more specifically with the potentialities of the scientific liaison offices.

There was no disposition on the part of the delegates to encourage the over-organisation of such interchange or movement of scientific workers. Dr. Hamilton, for example, suggested that the advantages of a centralized liaison office in peace-time might prove less real than war-time experience appeared to indicate. Informal as well as formal contacts are required, but in both, the contribution of the Government is important in creating the conditions favourable to movement, whether as Dr. Schonland suggests by arranging reduced air or other travel charges for scientific conferences, the travel grants recommended by the Royal Society, and especially in the report of its Geography Committee, and earlier by the British Commonwealth Science Committee, or by the superannuation and pension schemes stressed in the recent Colonial Office paper on the organisation of the Colonial Service. The recommendations of the Empire Scientific Conference on this question of interchange of scientific workers are clearly designed to promote such conditions, and it is to be hoped that they will receive careful attention by the universities and research institutions as well as by the University Grants Committee, the Lord President of the Council and the Chancellor of the Exchequer. No standard of staffing of the universities or research institutions which does not allow for such special leave without undue burdens on the remaining scientific staff, or financial or other obstacles to travel, can be regarded as making adequate use of the Commonwealth's precious asset in scientific man-power.

Beyond this the Royal Society envisages that in the interests of scientific progress it may often be desirable to invite foreign research workers to Great Britain, and funds should be available for this purpose. Finally, the Council comments on the need for grants for publication. Owing to the rise in the cost of publication and the large volume of work that has accumulated for publication during the War—the report estimates that in physics and chemistry alone, at least 2,000 separate papers will be released for publication—substantial further assistance will be required from the Treasury. The Council estimates that the annual Parliamentary grant for scientific publication should be increased to about £10,000 for the years immediately following the end of the War.

The importance of attention to this question of publication if duplication of effort is to be avoided and full economy of man-power achieved need scarcely be stressed further, but here the Royal Society report touches on the question of scientific

information services to which the Empire Scientific Conference devoted some attention. That is an important question of tactics rather than research strategy but cannot be discussed further here, though it may be said this report should help to stimulate the action called for in the British Commonwealth Science Committee's report in 1943 and more specifically in the recommendations of the recent Conference. Generally, in fact, it may be said that the recommendations of the committees, in so far as they have not fallen within the general category adumbrated by the Council of the Royal Society as indicated above, fall rather within the sphere of tactics than of strategy, and give less indication of what effort is required or of the specific subjects to be explored than might be expected from the broad title of the report to which they are appended.

Certain specific fields are indicated in the report; and in the recommendation of the Empire Scientific Conference directing attention to this report, reference is made to the shortage in the Commonwealth of scientific workers in such fields as taxonomy, genetics and microbiology. That the quantitative needs in terms of man-power and finance should be thus assessed is, of course, all to the good and a step that should prove of material assistance to the University Grants Committee under its new terms of reference as well as to the Committee on Scientific Man-power and the Hankey Committee. In its latest broadsheet, "Manpower Stocktaking", P.E.P. has emphasized once more the importance of forecasting the requirements of the professions and the upper ranks of industry, commerce and the Civil Service to ensure that there is no shortage of persons trained for these occupations. Equally it is clear from the terms of the recommendation of the Empire Scientific Conference that the report is only a first contribution to the planning that has still to be done to foster fertile research in all important subjects. The real work lies ahead, and the omissions from the report, the responsibility for like surveys which by implication is placed upon the Medical Research Council, the Agricultural Research Council, the Colonial Research Council, and the Advisory Council for Scientific and Industrial Research, indicate that as yet only a preliminary move has been made in the survey and planning of resources required if the advance of science is to proceed on a more even front and the gaps in knowledge are to be filled. Moreover, there are still the social sciences to be considered, and the recent report of the Clapham Committee on the provision for Economic and Social Research has indicated another big demand on the universities for trained man-power and another wide field in which our research effort needs to be co-ordinated and planned to secure the most effective use of limited resources.

When that has been said, the findings of the Royal Society's report and the recommendations of the Empire Scientific Conference on this matter of post-war needs in fundamental research and in the ancillary question of the interchange of scientific workers throughout the Empire give further point to ideas which are already common ground in most discussions on scientific and industrial research to-day. These ideas are now expressed in a form more suitable as a basis for the government action required. Some parts may indeed require further examination and study, from scientific workers individually as well as by their professional and learned societies and by such bodies as the universities and the University Grants Committee. Their full implications may require elaboration, but it is to be hoped that scientific workers as a body will rally to the task of education and interpretation, as well as investigation, which has still to be done before appropriate government action can be secured even on lines thus authoritatively commended both by the Royal Society and the Empire Scientific Conference. Beyond this there is the question, on which neither the Royal Society nor the Empire Scientific Conference makes comment, of the authority or means for determining the distribution of our scientific effort as between teaching and research as well as between different branches of science and between fundamental and applied research. Until the further surveys indicated have been made, no decisions as to distribution can be taken beyond the broad priorities indicated in the Barlow Report. But while such surveys are proceeding and until some appropriate authority or machinery for reviewing the results of the whole survey is established, we remain in danger of dissipating our resources of man-power, of duplicating effort and of neglecting important fields while permitting activities which are less efficient or less fruitful from the point of view of scientific advance or national welfare.

MODES OF MATHEMATICAL THOUGHT

Die mathematische Denkweise

Von Andreas Speiser. (Wissenschaft und Kultur, Band 1.) Zweite Auflage. Pp. 122+9 plates. (Basel: Verlag Birkhäuser, 1945.) 14.50 Schw. francs.

THIS is a remarkable book. Sometimes it is a brilliant book, at other times an infuriating book. For all these reasons it must be reckoned with, and its author congratulated upon achieving a result by no means out of proportion to his labour, which must have been prodigious. The reader, however, will only appreciate what lies before him if he has the requisite patience to pick his way amid what looks occasionally like an almost impenetrable jungle, so thick, in fact, that whatever it is like outside, the sun seldom gets through.

Such an impression of obscurity arises not because we are facing a rather formidable treatise in German; it is inherent in the way that the author thinks. And to a considerable extent he is perfectly right. An error of to-day is over-simplification, and he will have none of it. It follows, perhaps, that scarcely anybody will read this volume with the care it deserves. If that proves indeed to be the case, it will be a pity, for in these pages is much hidden treasure. However, now to their contents.

After some preliminary matter comes a chapter on the symmetry of ornament, then one on musical form. We are next confronted with discussions upon the natural philosophy of Dante, the position of Proclus with regard to mathematics, together with

space and time in Neoplatonism. Then follows a section on Goethe's colour-theory, and another on astrology, rounded off by a summary. This is a little disconcerting, as we soon start off again (having naïvely imagined, perhaps, that a *Zusamenfassung* implied the end) upon a delightful quest for new significance in Kepler's world-harmony. Which done, back we go once more to music (some actual scores this time), finishing up with a beautiful series of plates, illustrative of the chief architectural and ornamental patterns mentioned in the text.

Now all this is very exhausting, and productive of a literary species of 'museum fatigue', which may well lead, in any but the hardiest, to premature collapse.

No useful purpose would be served by selecting here and there a passage from this book, and commenting upon it; in matters of this kind a reviewer may perhaps more profitably try to appraise the author's outlook and to present it—as in Gestalt-theory—as more than the mere sum of its parts. We see the synthetic process at work in the way the Logos problem is handled, and in the attempt to equate whole-number relationships to the harmony of the spheres. The former concept is boldly identified with group-theory (as we now understand it), thus paving the way for the suggestion that symmetry at least may be, and possibly is, the cause of beauty. This line of inquiry is taken up again later; meanwhile it is interesting to see some of the parallels which present themselves as soon as the writer's position regarding the Logos is accepted, and its influence upon physical speculation discerned. For Heraclitus, for example, the Logos is a relation, whereas for Philo the same mental construct is more of a bridge, a span in fact, between Judaism and Hellenism. Later, the Logos appears in an applied form, as in the Fourth Gospel, but with the stress upon word rather than upon reason. The present author's position is essentially of this nature in the use he makes of the Logos—indeed, none other than Philo's—for his own ends, namely, to establish the cardinal point occupied first by groups, next by symmetry, and lastly by beauty. It is of little avail to be impatient with the complexity of all this, or to take refuge in some positivistic formula: mankind surely craves for beauty, and if so be it is forthcoming, the question whence it comes will always be asked. For the mathematician, beauty may be paramount in deciding which road he shall take in future investigations (as Dirac once pointed out), even to the extent of claiming it as a discriminant for "the more excellent way". And assuredly symmetry is close at hand. Köhler and some psychologists would probably fasten upon this as an example of 'requiredness'. What matter if they do? As things stand at present, we use the word 'inevitable' far too often, and without a full sense of responsibility. If æsthetic satisfaction could be taken less grudgingly than in some quarters it is, the end-state would be more likely to correspond to a true repose of mind. This, be it noted, is not what Prof. Speiser actually says; it is what his particular *Methodik* implies.

All this is very much to the good; the misfortune is how hard it is to make use of it here and now. Inherent in such a philosophy is the condemnation of that degree of specialization which makes people excellently equipped for (say) technology, but relatively incapable of sensing the beautiful. In a word, the Logos bids us beware of professionalism run riot, and the neglect of knowledge for its own sake.

To return for a moment to symmetry. The kaleidoscope, as the author points out, provides a crucial experiment by which to test the dependence of beauty upon orderly arrangement. The phenomenon itself is well known; what is valuable is the frank recognition that hereabouts, at deep psychological levels, lie the dispositions vital to artistic activity, and in so far as they may be traceable to number, they tend to emerge as the basis of music. This approach seems preferable to the more common, and somewhat erroneous, remark that architecture is frozen music. Of course, there is some degree of unconscious strife between the visual and the auditory, which Speiser is, for the moment, inclined to blanket. It does not matter very much except that, for example, sound has far to go to catch up with sight in experimental psychology. The integrative faculty may be very much a virtue in the right place. In the meantime, the omission of these cognate questions is something of a weakness, which seems to indicate a tendency to work too much in a vacuum.

While on this subject of symmetry, the author reminds us of a number of things not so well known as they might be. For example, the architect of Santa Sophia contributed notes on the angles of regular polyhedra, and the great artist Piero della Francesca a discussion of much the same kind. Pacioli wrote on the Golden Ratio, and, perhaps rather more surprising, Albrecht Dürer surveyed the regular partition of planes. In addition, Archimedes seemed to have had considerable influence over the rise of mosaic decoration, while finally comes the outstanding case of the assemblage of stone elements into a pattern representing the theorem of Pythagoras. In this last instance, the physicist of to-day will recognize a familiar theme, namely, the difference between the 'ideal' and the 'real', for it was due to the putty in making good the imperfections that the design could be accomplished. How familiar all this seems to the crystallographer, forced to concede some kind of 'Lockerstellen' to his theoretically perfect architecture. So the process goes on, in a continuous effort to adjust, and to take up the slack.

Seen at a wider angle, the effect of some of these early efforts upon creative minds is very significant. Leonardo da Vinci was fascinated, literally fascinated, by the works of Archimedes, and made great sacrifices to study them. One result was to induce a veneration for natural law which went far to dominate Leonardo's later years, and to shift his interests away from painting. Or so, at least, his contemporaries said. Altogether, one is left with the impression that 'pure knowledge' and 'applied knowledge' are inextricably interwoven, and that much of the controversy concerning their respective positions is somewhat meaningless. What stands out is the importance of the study of the history of science: those who have given marked attention to this discipline have been among the most fruitful in original research and discovery.

From here it is an easy step to see what the author has to say on the subject of Goethe's colour-theory, and the unavoidable conflict with Newtonian philosophy. On the whole, the approach is conventional: Goethe's view is not physics at all, but a description of what he sees. For him, colour is akin more nearly to a circle than to a line; the visible spectrum alone is conceived as important, in contrast to the scientific worker's attitude towards it as a mere portion of electro-magnetic phenomena to which the human eye happens to be sensitive. And Goethe disliked mathe-

matics particularly. All very true, but Sherrington has said as much, nay more, and with a very tender touch in his Deneke Lecture at Oxford in 1942. The book before us is actually a second edition (the first was published in 1932), so one cannot reasonably complain; but this habit of self-limitation is one which it would be good to see removed in any future impression. Incidentally, the innate lack of humility (the late Prof. Collingwood would have called it 'inevitable' whether innate or not) of the virtuoso is thoroughly exposed in Goethe: it is what *he* sees and feels that matters; he and his are at the centre of the universe. Nevertheless, the great man's comprehensiveness knew no bounds, and mathematicians will gladly share his passion for Nature, "a numinous presence . . . operating the gates of birth and death" (Sherrington).

A brief reference to Prof. Speiser's outlook on Dante's natural philosophy must suffice. He notes the use of geometrical symmetry, and the attempt to apply it to the moral sphere. Certainly, nobody has seriously contested the success of the *Weltanschauung* of the Divine Comedy in certain spiritual aspects of Platonism.

A good example of the author's originality of mind, and of his resilience, is displayed in his discussion of the horoscope, which follows upon a detailed résumé of the main tenets of astrology. The question is bluntly asked: Why is the horoscope in many cases so successful? In view of the fact that no causal connexion exists between it and mankind, such a query is very pertinent, and the suggestion is that in the theory of *déjà vu* a solution may be found. This is a reasonably well-known psychological effect according to which, as the name implies, one has a wholly convincing sensation of having 'already seen', heard, taken part in, or experienced, a situation in which one is actually involved (nominally for the first time) at the moment. Clearly there are instances in which such a conviction cannot possibly be accepted; but in the matter of *judgments*, the evidence is more favourable. An attempt to probe this now would scarcely be appropriate: men so far removed from each other in time and space as Plotinus and Bergson have each been aware of this profound property of human schemata. Actually, several occurrences have been investigated in recent years by Pickford, with scientific rigour, including a remarkable painting, executed by one of his students, and called "Abstraction".

It remains now to notice the admirable series of plates with which Prof. Speiser's book ends. They are so not merely because they represent technical skill on the part of the printer—their æsthetic appeal is to the mind as well as to the eye: in this they reflect 'the beautiful' of the mathematician. Spirals, polygons, contacts of various orders, space-groups, rotation-axes, glide-planes, all are there "for delight", as the Song of Solomon would say. (On p. 122 appears to be a misprint, namely, "VII" for "VIII", which is a little confusing.)

The reader, if he is to enjoy all this to the full, needs two other books at his elbow, namely, Prof. Speiser's own "Theorie der Gruppen von endlicher Ordnung" (Berlin, 1927) and Birkhoff's "Aesthetic Measure" (Harvard, 1933). Then he can be really happy.

To sum up. The volume before us is not exactly a composition in the grand manner; it is more like a lovely little symphony made up of a number of movements, as unexpected as they are revealing.

F. IAN G. RAWLINS

DEMOCRATIC VALUES

The Quest of American Life

By George Norlin. University of Colorado Studies Series B. Studies in the Humanities, Vol. 2, No. 3. Pp. xvi + 283. (University of Colorado, 1945.)

American Interpretations

Four Political Essays. By David Mitrany. Pp. v + 124. (London: Contact Publications, Ltd., 1946.) 6*s*. net.

The Development of the Soviet Economic System

An Essay on the Experience of Planning in the U.S.S.R. By Alexander Baykov. (National Institute of Economic and Social Research: Economic and Social Studies, 5.) Pp. xv + 514. (Cambridge: At the University Press, 1946.) 30*s*. net.

Our Threatened Values

By Victor Gollancz. Pp. 157. (London: Victor Gollancz, Ltd., 1946.) 5*s*. net.

WITH a year of peace behind us and the high hopes of victory replaced by a mood which must in frankness be called one of disillusionment, this seemingly haphazard collection of four volumes presents a stimulating survey of some of the background of the ideological differences that mark the relations of Britain with the two leading powers of the world, the United States and the U.S.S.R. It would have been naïve to imagine that the comradeship of war could have removed these differences or even have contributed to their mitigation; but there was from 1941 a widespread hope in Britain that a greater mutual understanding would arise, and if public goodwill could have created that understanding it would certainly have come. In the event, however, the joint victory has served but to emphasize the differences. True, there is at this time, in all probability, a greater appreciation among British people of the American outlook than has ever existed before, and a greater patience with what seem to the Briton the vagaries of American political life. But with the U.S.S.R., on the other hand, a closer acquaintance has thrown into relief a fundamental difference of outlook. With the best will in the world to understand and to work in common partnership for peace, the British people are frankly puzzled, and it has become clear that many of the formulæ of Allied unity issued during the War were face-saving devices that served to conceal what they could not cure. By 'democracy', for example, the Russians obviously mean something far removed from the Anglo-American conception of the word. The fundamental distinction can be expressed quite simply. The Russian view of democracy is essentially collectivist: it is government in the interests of the many, the proletariat, how exercised, or by whom, being details of lesser importance provided that the interests of the majority are genuinely served. "Democrats," Mr. Vyshinsky has said, "are those who give their efforts to the service of the people, who are ready to sacrifice even their lives, who work for the people." It is a definition that has little relevance for Britain and America. For them democracy is essentially individualist: it exists to give the citizen the fullest possible scope for his development as an individual rather than as a unit in a collective grouping.

The two conceptions have their origins in different conditions—religious, political, social, economic, historical and geographical, and they can only be understood in the light of these conditions. It is urgently necessary not only that we should endeavour

to understand those conditions, but also that we should re-examine our own creed in the face of the Russian challenge and determine what modifications are demanded by the changed circumstances of the modern world. A static creed has little chance of survival, and little to offer to peoples who have yet to attain a measure of political maturity and who are seeking guidance. Hence, in part, some of our present difficulties in the international sphere.

For Americans the response to the challenge of modern conditions has been a re-assertion of traditional values, but a re-assertion that has taken heed of present-day needs and has found in traditional values themselves both the means for change and the will to use them. Prof. Norlin's "Quest of American Life" is a historical re-statement of the idealism that has always coloured American development, of the resistance to tyranny and to government control that took the Pilgrim Fathers to the New World and gave mankind the Declaration of Independence. The Americans, as Prof. Norlin points out in a striking phrase, have been a *protesting* people, and the conditions under which they lived, in a vast continent over which they were able to expand freely, enabled them to develop from its grounding in religion their individualist conception of political liberty. To this conception Prof. Norling gives the name of humanism, arguing that such alternatives as 'liberalism' and 'democracy' have become spoilt by use. He does not pretend that American life has often attained the ideal of humanism, but he is able to show that at every stage in the growth of the American nation the spirit of humanism has inspired active protest against abuses, whether from outside or from within. Thus, the same spirit encouraged resistance to British rule, to secession, and, at the end of the nineteenth century, to trusts and corruption. In the main, humanism has stressed individualism against government control, but government intervention in defence of the individual has frequently been necessary, and in an increased emphasis upon 'the common welfare' Prof. Norlin sees the salvation of American democracy.

Prof. Mitrany, whose work is well known to English readers, takes up the story where Prof. Norlin breaks off. "American Interpretations" consists of four essays on related themes—the New Deal, the American labour movement, U.S. relations with Latin America, and American opinion on foreign policy. In all four the important changes that have taken place in American life since the great depression are well brought out, and though the essays are short they are closely reasoned and reveal clearly the underlying vigour of American democracy that made possible the achievements of the Roosevelt era. The New Deal is shown to be both a revolutionary and a traditional movement; revolutionary in aiming at greater social justice, traditional in that greater social justice had always been the ideal of American endeavour. "American history," says Prof. Mitrany, "is in effect the story of a never-ending quest for a new deal. . . . The New Deal one might say was the magnificent response of a people bred in self-reliant democracy to a crisis in their social outlook and life." The theme is developed in a manner to stimulate thought, and of particular interest in the first two parts of the book are Prof. Mitrany's comments on the passing of "rugged individualism" and on the increasing centralization of government which has revolutionized traditional conceptions of the American constitution.

From these two books it is possible to form some estimate of the American response to contemporary problems. The third, Dr. Baykov's "Development of the Soviet Economic System", carries us into the world of planning, and provides a mass of statistical material on the economic evolution of the Soviet Union. Dr. Baykov's justification for adding to the formidable literature on the subject of the U.S.S.R. is his view that the economic organisation of the country can only be understood in the light of the whole process of development since 1917, and that, in particular, it is only through study of the whole period that the error of regarding passing phases of the system as permanent features can be avoided. Although Dr. Baykov is concerned only with economic aspects of Russian life the warning is a salutary one, and a reminder that certain features of war-time experience are also no more than passing phases. From the book it is possible to form a detailed impression of the sweep of Soviet economic life, and the magnitude of the achievement is made clear. It is, perhaps, irrelevant to complain that the book never comes to life, for it is not intended to be more than an introduction to a study of theory and statistics; but it is well to endeavour to interpret it in terms of human life and livelihood—to recall, for example, what was entailed in the laconic statement from an official publication on the subject of the First Five-Year Plan, which Dr. Baykov gives in a footnote, "The financing of this plan is like putting a steel ring on consumption"; or the price paid in human suffering for the success of the policy of agricultural collectivization, to which Dr. Baykov barely refers. And at this present moment the use, in 1927, of the argument, which he mentions without comment, that the Plan was necessary in view of the possibility of a British attack, is of particular significance.

Dr. Baykov is chary of drawing conclusions, preferring to leave them to his readers, but he commits himself to some generalizations of surprising naïveté. On p. 360, for example, he writes that "the history of labour relations and the development of the U.S.S.R. economy . . . have shown that even in the economic sphere of human activity, motives other than material can be driving and creative forces", a truism which we scarcely need a communist revolution to teach us.

It is to be regretted that Dr. Baykov has not attempted any critical assessment of the achievements of the Soviet Government; but the book is intended for the specialist reader who can form his own views. Mr. Gollancz, on the other hand, addresses his pamphlet, "Our Threatened Values", to the general reader, and with great moral warmth—and rather more ability than he modestly claims for himself—he upholds the Christian-Liberal tradition, which Prof. Norlin would call 'humanism', against the present tendency towards lowered standards. Mr. Gollancz is particularly concerned with our treatment of Germany, and he makes an impassioned plea for a more liberal, and more enlightened, treatment of that country of despair. But his fundamental concern is with the moral crisis of Western civilization, with the diminished "respect for personality" of which he sees alarming evidence around us, and in giving his evidence he is especially critical of the policy of communism. In the matter of respect for personality, he argues, communism and Western civilization are, in practice, totally opposed: Soviet Russia has so exalted the means of power that the liberal ends of Marx's original doctrine have been thrust into the background. It is an important point of view that

must not be overlooked, though Dr. Baykov might retort that Mr. Gollancz was misinterpreting a passing phase. But Mr. Gollancz is on unchallengeable ground when he makes a plea for the "moral leadership" of which he believes Britain to be still capable. America produced a Roosevelt to revitalize its democracy in an hour of crisis. Can we produce another Gladstone? Mr. Gollancz would probably agree that something of the Gladstonian moral fervour is required.

MAURICE BRUCE

A SURVEY OF SEX

Sex, Life and Faith

A Modern Philosophy of Sex. By Rom Landau. Pp. 319. (London: Faber and Faber, Ltd., 1946.) 21*s*. net.

MR. ROM LANDAU nowhere claims to speak as an 'authority' on sex and is none the worse for that. His publishers, however, do him no service by describing this volume as "possibly the most outspoken, provocative and comprehensive book on sex to appear since *The Psychology of Sex* by Havelock Ellis" for, by the bright light of Ellis, Landau looks rather dim. But then, who would not? Take Mr. Landau at his own valuation as one who has frequently been asked to advise people on their sex problems and who has read rather widely in the literature of sex, and one must admit that his advice is on the whole sound and his reading well digested. Mr. Landau, moreover, *can* write—which is more than may be said of some so-called 'authorities'.

The book certainly justifies the description of "outspoken", for whatever the author's failings may be, mealy-mouthedness is not among them. In these days of polite understatement it is a joy to read his forthright denunciation of "miscellaneous religious circuses and revivalist kindergartens", of the "semi-dressed, silk-stockinged nymph errant of the strip cartoon" as "the little man's daily safety-valve, and symbolic of our whole attitude to sex", and of the "panvirilist aspirations of the 'suffragette' type"—although in this last case Mr. Landau is perhaps carried away by his enthusiasm when he finds himself agreeing with St. Paul that "man was not created for the sake of woman, but woman for the sake of man".

In somewhat similar fashion, the author's generalizations are occasionally rash. It would, for example, be difficult to justify such statements as "It appears that those who show the healthiest attitude to sex are the British seamen", or "the German has hardly begun to gain mastery over his sexual instincts"—or even "more often than not people are sexually attracted by types not similar but opposite to their own".

The claim to comprehensiveness is also justified. The author ranges over the physiology, psychology and anthropology of sex; sex in politics and art; marriage, fidelity and polygamy; homosexuality and sublimation; the attitudes to sex of the various churches; and the contribution which religion can make to the solution of the problems of sex behaviour. Herein, indeed, lies one limitation. When so many topics are discussed in so few pages, none of them can be discussed exhaustively. This, however, is not a condemnation of the book, for reconnaisance has its function as well as consolidation.

In brief, this volume is a well-written survey of sex in many of its manifestations, which may be read with some profit by any interested person. This review cannot close, however, without a protest at Mr. Landau's ascription to the late Dr. Temple of the view that sex is "man's greatest sin". One need not rely on one's own conviction that this is totally out of the late Primate's character, for we have his own words. In "The Church Looks Forward" (Macmillan, 1944), Dr. Temple wrote: "Sexual sin is not the only sin nor the worst kind of sin; the supreme sin and the fountain-head of all the others is pride, not lust"—which statement seems sufficiently unequivocal.

CYRIL BIBBY

MODERN ASPECTS OF PLANT NUTRITION

Trace Elements in Plants and Animals

By Prof. Walter Stiles. Pp. xi + 189 + 7 plates. (Cambridge: At the University Press, 1946.) 12*s*. 6*d*. net.

THE part played by minor or trace elements in the economy of plant life has only become apparent since the beginning of this century, and most of the work on the subject is comparatively recent. Nevertheless the literature on the subject is now so voluminous that it is very difficult to survey the present position, putting the right emphasis on the different aspects of the problem. This difficulty is specially acute in the case of biological students, who are expected to have some insight into such an important subject, but have neither access to much of the literature, nor the critical knowledge to enable them to select the most essential features of the work that has been done.

Prof. Stiles has outlined the subject in such a way as to meet the needs of such students, and also to provide a useful reference volume for research workers in the same field. His historical introduction includes a priority list giving the names of workers who first realized that particular minor elements were favourable to the growth of certain species; but he is careful to insist that these are not all claims that the element is essential. Some account is also given of methods of purification of salts used in nutrient cultures, the methods of estimating the minor elements in plant material, and the way that mineral deficiencies can be diagnosed. The discussion of trace-element deficiency diseases in plants is wisely confined to a small group of elements on which considerable work has been done, and the results generally accepted as proving the case. Manganese, boron, copper, zinc, and to a less degree molybdenum are all recognized as being necessary in small amounts for the well-being of many, if not all, species of plants, diseased conditions or failure to develop normally resulting if the element is not present or is in too short supply. The actual function of trace elements in plants is still a matter of much controversy, and only in a few cases can any dogmatic statement be made. The various hypotheses and claims are indicated; but much work will need to be done before definite proof can be obtained.

A short account is also given of the study of trace elements in animals, though far less work has been done in this connexion. Certain diseases are recognized as due to excess of trace elements, and the value of traces of copper, iodine, manganese, and cobalt for healthy growth is also clear, but here again much research is needed. An index and a selected bibliography of about 450 references provide useful guides to those who wish to follow up the subject.

W. E. BRENCHLEY

Co-operative Living in Palestine

By Henrik F. Infield. (International Library of Sociology and Social Reconstruction.) Pp. xii + 145 + 8 plates. (London: Kegan Paul and Co., Ltd., 1946.) 7*s.* 6*d.* net.

VISITORS to Palestine have been greatly impressed by the achievements of the 'Kvutza' ('group') settlements which are described in this book, settlements of Jewish immigrants who have surrendered everything they possess to the community and who work together in a fully co-operative enterprise. The idealism that has inspired these settlements is one of the finest aspects of the Zionist movement, a sense of a historic mission "to prove to the world that given an equal chance the Jew could be as 'productive' as anyone else"; hence the work on the land, the extreme simplicity of life in the settlements, the communal ownership, the effort to be self-supporting. Dr. Infield, after escaping from Nazism, spent some time in Palestine making a systematic study of these settlements, and has endeavoured since he settled in the United States to form some conclusions about them which might be of wider application. On the whole his conclusions are not encouraging. Without the driving force of Zionist idealism, and without material aid from the Zionist movement itself, the 'Kvutzot' could scarcely have succeeded: should Zionism fail, Dr. Infield points out, they would vanish. Yet an idealism that enables its devotees to face hard work and poverty—and even to allow the community to dictate how many children may be born!—is a force to be taken seriously: it is the other, brighter side of the picture of fanatical violence that is now all too familiar.

Dr. Infield has little to say about the problem of Palestine in general, but he makes a few revealing comments, as when he notes the despair of some 'Kvutza' members who, struggling to understand the Arab point of view, find "how far removed the fellah's sentiments are from theirs". To the British administration Dr. Infield is quite unsympathetic. It is a pity that when preparing the book for publication he overlooked the fact that since he had written the first draft the McMahon–Hussein correspondence of 1915–16, to which he refers on p. 99, had, in fact, been published.

MAURICE BRUCE

Handbook of Infectious Diseases

With Notes on Prophylaxis, Serum Treatment and Vaccination. By the staff of the Cantacuzène Institute under the direction of Prof. C. Ionescu-Mihaesti and Prof. M. Ciuca. Pp. 331. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1945.) 5*s.*

THIS useful book, which has been brought up to date with the aid of information collected during the recent war by the Health Section of the League of Nations' Secretariat, is intended for medical practitioners or public health experts; but it will be useful to many others also. Small in size—it measures only about 6 in. × 4 in.—it contains a great deal of information. Part I gives essential facts about the infectious and parasitic diseases of man, whether these are caused by bacteria, filter-passers, viruses, protozoan and metazoan parasites or fungi. The cause, methods of infection, symptoms, diagnosis, prognosis and treatment of each disease are given and a valuable feature is the list of names given in various languages to each disease. The reader is, for example, safely steered through the possible confusions between English "epidemic typhus", often loosely called "typhus", and German "typhus", a word which means in English the disease called typhoid fever; he also avoids confusion between the Italian "Tifo abdominalis" (typhoid fever) and "Tifo petecchiale" (epidemic typhus fever). Part II is devoted to an outline of general and specific immunology. It contains a useful account of the biological tests used for diagnosis, such as the tuberculin and Schick tests, and chapters on preventive vaccination, vaccine treatment, treatment with bacteriophage, treatment of infectious diseases by transfusion and by sulphonamides, with a section on antibiotics. Part III deals with the collection of pathological specimens, the capture of insect vectors of diseases and includes brief directions for the bacteriological examination of water.

There are few books upon these subjects which summarize in so small a space and so convenient a form so much information as this 'pocket edition' contains. There are fewer still, if any, which give so much for so moderate a price.

G. LAPAGE

The Sulphonamides in Theory and Practice

By Dr. J. Stewart Lawrence. Pp. vii+126. (London: H. K. Lewis and Co., Ltd., 1946.) 9*s.* net.

THIS small book, founded upon the author's own experience and a survey of 324 references, presents the subject from a very practical angle. "Theory" is included in the title, but this aspect is dealt with only briefly, and though the presentation is interesting and instructive to the clinician, it will have no appeal to the laboratory worker or to anyone seeking advanced knowledge on chemotherapeutic theory. Indeed, recent work, which has shown that the *p*-aminobenzoic acid substitution theory is by no means a full explanation of the mode of action of sulphonamides, is not described. The pharmacology of the group is well done, but the author is obviously most at home when dealing with the clinical aspect, which occupies three quarters of the book. This section, which has a remarkably good index, should be of the greatest use to the clinician. Starting with general considerations and principles, there follows, rationally, a description of the various organisms susceptible to sulphonamides, before regional affections are approached. One chapter is devoted to toxic effects and another (which every practitioner should read and learn) to the common abuses of the sulphonamides, with emphasis on indiscriminate use. This book can be recommended to all those engaged in the active practice of clinical medicine.

On the Nature of Value

The Philosophy of Samuel Alexander. By Milton R. Konvitz. Pp. viii+119. (New York: King's Crown Press; London: Oxford University Press, 1946.) 13*s.* 6*d.* net.

DR. KONVITZ'S exposition will do little to help anybody to understand Alexander's theory of value, since it lacks the admirable clarity and order of the original. He does, however, have some pertinent criticisms to make and some most interesting suggestions towards a theory of his own. If he can work them out systematically he will have something important to say. While differing in other respects, he evidently retains one excellent feature of Alexander's thought. He sees that the scientific, æsthetic and moral forms of judgment are distinct species and yet closely interrelated.

H. G. WELLS: A SURVEY AND TRIBUTE

By Sir RICHARD GREGORY, Bart., F.R.S.

CREATIVE ideas, and the influence of their expression, constitute a measure of material and intellectual advance displayed in the works of science and literature. Science is now commonly understood to be systematic and formulated natural philosophy; but with achievements in these fields of human understanding are also associated moral and social forces which, though not of a physical kind, are observable in their effects and admit of rational analysis and judgment.

This is the domain of what Wells defined as human ecology; and all his works—novels, fantastic and imaginative romances and books upon social, religious and political questions—are concerned, directly and indirectly, with individual and social factors involved in the biological whole. As a philosophy of matter, life and mind and their relationships to one another, he may be said to have expressed independently much the same evolutionary principles in diverse ways as those presented by General Smuts in his "Holism and Evolution", published in 1926. Moral as well as material values enter into this new humanism, and the adaptation of them to worthy conditions of life must continually create new problems for civilized societies to face and to solve, the tendency always being towards integrations of increased complexity and therefore of increasing difficulty of adjustment.

This was consistently the attitude taken by Wells towards human thought and action. In a Friday Evening Discourse at the Royal Institution in 1902, on the "Discovery of the Future", his thesis was "that mankind was at the dawn of a great change-over from life regarded as a system of consequences to life regarded as a system of constructive effort. . . . We should be less and less bound by the engagements of the past and more and more ruled by a realization of the creative effect of our acts". He did not say that the future could be foretold, but he held that its conditions could be foretold.

Thirty-four years later, in another Discourse at the Royal Institution, Wells again expressed what was always dominant in his mind—to relate effects to causes and arrive at generalizations and syntheses. His temperament and endeavour were those of a scientific inquirer into individual experiences and their collective relationships, with the same independence of customary authority as that of the Horatian motto *Nullius in verba* of the Royal Society, but with much greater perplexities to study than those of the concrete natural sciences. The subject of the Discourse at the Royal Institution was "The Idea of a World Encyclopedia", and the object was the collation of all published knowledge in the world by, with and for the world.

The conspectus of such a vast undertaking can be found in Wells's "Outline of History", "The Science of Life", with his eldest son, G. P. Wells, and Julian Huxley as joint authors, and "The Work, Wealth and Happiness of Mankind", successively published from 1920 to 1932. The "Outline" is a story of the earth as the abode of man from his earliest appearance on the planet to the Peace of Versailles; the "Life" deals with biology and social structures; and "Work" with ways in which humanity earns its living. As contributions to the history of man and his activities, these three works constitute a supreme achievement which could not have been conceived and constructed by any historian without his scientific credentials. He was as aware as anyone of certain weaknesses and deficiencies; but he welcomed suggestions to remedy them as well as to include new discoveries relating to human evolution and history, particularly in revised editions of the "Outline".

To have mastered such a vast body of human thought and action, and to have kept abreast, as Wells did, of current knowledge and opinion on many technical subjects, was an intellectual feat which no other modern man of letters could possibly have achieved. Referring to these historical surveys and attempts to bring economic, financial and social life into rational relationship, he said at the Royal Institution ten years ago that he had been engaged in the "still more desperate struggle to estimate the possible consequences of this or that set of operating causes upon the future of mankind". His imaginative romances, as well as his works on social, religious and political questions, reflect his reactions to historical or visionary influences upon modes of human existence. On the magic carpet of his mind he could travel backward or forward in time and space and live in ideals so vividly that they became convincing realities in narrative.

The first scientific fantasy of this kind was "The Time Machine", a rough draft of which appeared in the *Science Schools Journal* when Wells was a young man of twenty-one years. He had acquired a sound knowledge of the fundamental facts of astronomy and was able, therefore, to describe accurately the rapidly changing celestial scenes presented to the time traveller. The moon passed in an instant through all its phases, the sun became a band of fire and swayed up and down, from solstice to solstice again in a minute or less, with spring and winter merging into one another in the picture. Wells knew, better than any other man of letters, what such natural events and processes had been and that they were due to forces acting continually and uniformly. It was this scientific knowledge, combined with brilliant powers of expression, that made him unique in his own particular field.

After "The Time Machine" came "The War of the Worlds" as the second of a series of a dozen imaginative romances in which physical and biological factors were cleverly used. Lowell's work on the planet Mars, and his conclusions that the so-called canals had been artificially constructed by intelligent beings, had been published three years earlier, so Wells had a good basis for his story. The Martians he conceived to invade the earth brought novel heat-rays and a heavy gas with them as devastating means of conquest, but after a short time they themselves became masses of corruption due to insidious germs of disease which they had eliminated in their own planet and to which their bodies were, therefore, not immune. This end of the Martian invaders is a characteristic example of the application of scientific knowledge to forms and conditions of life woven into a story having also strong emotional appeal.

"The First Men in the Moon", published in 1901, again revealed his genius for producing a story rich in human interest without disturbing the sensibilities of critical scientific minds. In this respect, Wells's novel was far in advance of Jules Verne's "Journey to the Moon", which had many scientific blunders and inconsistencies. Moreover, Verne's travellers did

not reach the moon, whereas Wells's landed upon our satellite and found beings living inside it with thoughts and feelings which made contacts with human hearts.

So it was with the story "In the Days of the Comet", published in 1906. Several years earlier a remarkable new star appeared, visible to the naked eye, and expanding at such a rate that it was thought by many people to be a minor planet approaching the earth. Wells had a much better basis for his fancy when he made a comet cross the earth's orbit at a point near enough for us to pass through its tail, as actually happened in 1861. He let his imagination play with the idea that human nature might be changed by the introduction of a new spiritual element in the earth's atmosphere, represented by a peculiar greenish radiation from his comet's tail. After passing through the tail, the whole race was transfigured. Jealousy and hatred vanished, and with it war and poverty, in the vision of a world lifted out of acquisitive greed into a condition of celestial harmony. This poetic dream of what mankind might become by following paths of truth and righteousness and suppressing animal instincts is displayed in a number of Wells's works, often with hope but always conscious of the prevalence of evil tendencies in human nature.

In "The World Set Free", the transformation from old to new and better conditions of life and government was reached not through the swish of a comet's tail but as the result of a world war. The book was published early in 1914, but in substance and outlook it describes the Second World War even more closely than the First. The book was dedicated to Prof. Soddy's "Interpretation of Radium", published in 1909; and the theme is that of the disintegration of the atom and the use of atomic bombs and thousands of aeroplanes in modern warfare. As a story of the discovery and use of natural power to supplement man's animal strength, the first chapter of the book, entitled "The Sun Snarers", states these developments with crystal clearness. It outlines the conquest of external power in the industrial applications of fire, steam, electricity, and new chemical elements, leading up to radium and the release of the energy locked up in atoms, for use first with devastating effects in what was called "The Last War" and then, in 1956, to liberate the race from obsessions and entanglements which impede moral and material growth.

"Already before the release of atomic energy the tensions between the old way of living and the new were intense" are words used in the last chapter to introduce the assembly summoned to place social organisation upon a new and nobler footing. This council was constituted in the spirit of the United Nations Organisation, and it eventually led to the planning of a new common social order for the entire population of the earth. How close the realities will approach to Wells's ideals remains to be seen.

Other works in which the possible future of the human race was forecast are "The Sleeper Awakes" (1899), "Anticipations" (1901), "Mankind in the Making" (1903), "The Food of the Gods" (1904), and "A Modern Utopia" (1905). Of "Anticipations" Sir Ray Lankester said, in a five-column review in *Nature* of March 13, 1902:

"This is a profoundly interesting and suggestive book by a very remarkable man. Mr. Wells was educated at the Royal College of Science; he has a thorough knowledge of, and considerable training in, the great branches of science—physics, chemistry, astronomy, geology and biology. This course of study operated, in the case of Mr. Wells, upon a mind naturally gifted with an extraordinarily vivid imagination and the aptitude for true literary art."

This kind of encouragement from scientific friends was highly appreciated by Wells from the very beginning of his literary career to the end of his life. He was trained to become a science teacher, and during this formative period, as well as for several years later, his closest contacts were with workers in scientific fields. He knew that when he entered the world of letters, in which he afterwards attained international fame, he lost his place on the ladder on which he had been moving upward; but the fact that he continued to be regarded as a great scientific educator by leaders of his own generation, and an inspiration to the new, kept him continually in touch with advancing knowledge and contributed in no small measure to the remarkable responses represented in his works.

"Anticipations" projected the present into the future from the outlook tower of modern science. It was an indictment of many existing customs and structures and a prophecy of what changes might be expected in the near future. On the mechanical or inventive side, the predictions made in the book revealed an insight which was truly marvellous. Motor-cars and motor-roads were largely to replace railway traffic. Land ironclads, armoured trains, armoured tortoises or tanks and flying machines with folded parachutes for escape were to be used in warfare. Forty years after this forecast all these machines were in action, but their development has not been accompanied by the changes of heart and social structures which Wells hoped for but had not the same scientific reasons to expect to be fulfilled.

In "A Modern Utopia" (1905), faith in the principles of a rational social biology is expressed in practical terms with hope as well as ingenuity. The system presented resembles that of the Platonic Republic, save that insistence is given to the preciousness of individual freedom and to toleration. Family allowances were to be made to women, but criminals and certain other groups were not to be allowed to reproduce their kind, though they were free to follow their own proclivities in their own separate communities. The main idea was to keep learning and the applications of it progressive instead of fixed and pedantic, the spirit being, therefore, that of "The Discovery of the Future". This kind of idealistic Utopia is found again in "Men Like Gods" (1923). It makes man the master of his own house and conceives the birth of a new race with noble qualities of mind and great physical strength, devoted to the understanding of Nature in all its aspects and its control for the progressive welfare of humanity.

Such projections as these into the future of man and society are not satires like Swift's "Gulliver's Travels" and Samuel Butler's "Erewhon", or parodies of science found in novels of our own times. They rank with Plato's "Republic", Thomas More's "Utopia" and William Morris's "News from Nowhere" in their social philosophy and as vivid literature. The world of science has every reason to be proud that its spirit and service should have been translated so genuinely and loyally into "Thoughts that breathe and words that burn" with such unsurpassing power and influence as those possessed by Wells. He presented scientific workers to his readers as human beings and not as the travesties in which

they figure in novels and romances written without his intimate knowledge of them and their impulses. That is why homage has always been gratefully paid to him in these columns and in other scientific periodicals.

"By science," Wells once said, "is meant a process of human intellectual energy which is exhaustively and reverently criticized, leading, it is hoped, to action exhaustively criticized before it is exhaustively planned." In these words he expressed the whole of his faith, the whole of his belief in human life. How and why he acquired this faith and proclaimed it is comprehensively stated in the two volumes of his "Experiment in Autography" (1934), the sub-title of which reads "Discoveries and Conclusions of a Very Ordinary Man". He looked at people and their actions against a background of knowledge never used before to paint pictures of aspects of individual and social life; and his insight as well as the breadth of his experiences made all the scenes and figures stand out with convincing reality, even when they were fanciful.

From first to last the characters in all Wells's works represent growing experiences and the responses of thought to them. Following scientific methods, he observed ways and means of life independently, described faithfully what he saw and deduced principles from this evidence. "Love and Mr. Lewisham", "Kipps", "Mr. Polly", and "The Wheels of Chance" are stories in which he himself lived and struggled and thought. So it was with most of his other novels. When he left this field for that of scientific romances, literary critics deplored the change of front and his re-entry into a field in which he became the supreme interpreter.

Mention has already been made of the lines of these perspectives of space and time, and of some other adventures into the domain of human ecology. It is sufficient here to refer, in addition, to "The World of William Clissold", three volumes (1926), "The Way the World is Going" (1928), "The Open Conspiracy" (1930), "After Democracy" (1933), "The Anatomy of Frustration" (1936), "Star Begotten" (1937), in which the idea is used that cosmic rays directed towards the earth might induce mutation of genes in human nuclei, "The Fate of Homo Sapiens" (1939), "The New World Order" (1940), "The Outlook for Homo Sapiens", and "The Conquest of Time" and "Phoenix" (both in 1942), " '42, '43, '44: The Happy Turning", which is a supplement to the "Autobiography", and "Mind at the End of its Tether" (1945).

These, with other books already noted, comprise only a selected list of Wells's contributions to the study of social biology. They state the essential ideas of his life and draw the perspective of a world liberated from sectionalism, with men and women of goodwill and wide outlook co-operating in the task of constructing and maintaining conditions and ways of life worthy of human powers and the availability of the natural resources of the universe.

In "Ann Veronica" (1909)—a novel which provoked a storm of indignation from a group of critics, because of its frank discussion of sex relationships—Wells makes one of the characters say: "Find the thing you want to do intensely, make sure that's it, and do it with all your might. If you live, well and good: if you die, well and good. Your purpose is done." Before he wrote these words, Wells had had several reminders that his physical system was weak in several parts and liable to breakdowns. It was his indomitable spirit that urged him on to carry out his purpose for a much longer period than anyone who knew him when he began his literary career would have expected. This was maintained to the day of his death on August 13. A few weeks before his heart ceased to beat, he had planned to work hard at the scenario of a film to be "The Shape of Things to Come" brought up to date with the new ideas and curiosities due to the popularization of the principles of the nuclear disintegration of the atom and the manufacture of the atomic bomb.

To have had such an intention at seventy-nine years of age and after producing about a hundred notable volumes is an impressive example of the mental alertness and perseverance of purpose of Wells's life, the spirit of which remains in his works to enlighten the world for many generations. From his early days he was eager to learn and to master his circumstances. His father was a small tradesman at Bromley, Kent, where Herbert George Wells (familiarly known as "H.G.") was born on September 21, 1866. His mother was a typical representative of the lower middle class of Victorian times, with fixed regard for the established order and its conventions. This led to Wells being sent to a local 'academy' as a child instead of going to a national school.

With the same maternal desire that Wells should occupy a 'respectable' place in the social order, he was twice placed in drapery establishments, from both of which he came away with resentment at the life imposed upon him. Between these two experiences he was sent for a month's trial as an apprentice to a pharmaceutical chemist at Midhurst, Sussex; but this new start in life was abandoned for financial reasons. He began there, however, the study of Latin with lessons from the headmaster of the small grammar school, at which he became a boarder for a couple of months in the interim between the two drapery adventures. After breaking away from the second of these trials, he wrote to this headmaster, who, as the result, offered him a post as an usher in the Preparatory Department of Midhurst Grammar School.

It was at this place and under this influence that Wells made his first systematic acquaintance with modern science. There he attended evening classes under the Science and Art Department, and was so successful in gaining grant-earning certificates in a number of subjects that in 1884 he was accepted as a science teacher in training at the Normal School of Science, South Kensington, which later became the Royal College of Science.

After three years at the College, Wells left without being awarded the associateship, having failed in the examination in advanced geology. Even without this qualification he was able to obtain a post in a small private school in Wales, where he had his left kidney crushed during a football game and was wrongly pronounced to be consumptive, but later to be diabetic, which proved to be true. In 1889 he became an assistant master in a private school at Kilburn, where Alfred Harmsworth (Lord Northcliffe) had been a pupil, and Wells taught mathematics and science to a class which included A. A. Milne, the novelist and playwright, son of the headmaster of the school.

While at this Henley House School, Wells passed the London Intermediate B.Sc. examination with honours in zoology and was awarded the licentiateship of the College of Preceptors with the three prizes in theory and practice of education, mathematics and

natural science. These successes led to the offer of a post on the staff of the University Tutorial College, where he went to teach biology and also geology to students at Red Lion Square working for the University of London examinations. While there he took his B.Sc. degree in 1890 with first-class honours in zoology and was first in the second class in honours in geology. He also obtained the fellowship diploma of the College of Preceptors with honours in two subjects and gained the Doreck Scholarship for theory and practice of education, thus getting in front of university teachers in their own examination.

His career as a professional teacher came to an end in 1893 with another breakdown of health. It was then that he began to earn his living by writing articles for the periodical press on common subjects in his own whimsical vein of reactions to them. His "Select Conversations with an Uncle" (1895) is a collection of such contributions from scores of other unsigned articles and tales. He also contributed a number of reviews to *Nature*, including one on Podmore's "Apparitions and Thought Transference". His first book was, however, Part 1 of a "Text-book of Zoology" (1893), with an introduction by G. B. Howes, assistant professor of zoology at the Royal College of Science, followed two years later by Part II, and Gregory and Wells's "Honours Physiography". In the same year (1895) "The Time Machine" was published, and Wells found himself recognized, at twenty-nine years of age, as a bright star rising above the horizon of the world of letters to radiate a new penetrating light before men.

The honorary degree of D.Lit. was conferred upon Wells by the University of London in 1936; and in 1943 he was awarded the D.Sc. degree for a thesis on "The Quality of Illusion in the Continuity of the Individual Life in the Higher Metazoa, with Particular Reference to Homo sapiens". He was president of the Educational Science Section of the British Association at the Nottingham meeting in 1937, when he gave an address on "The Informative Content of Education", which led to the publication of two reports upon the subject by a research committee of the Association. He was elected an honorary fellow of the Imperial College of Science and Technology in 1943, just fifty years after the publication of "The Time Machine", the first of the imposing series of works by which Wells became the greatest international scientific educator of his times.

SEVENTY-FIFTH ANNIVERSARY OF THE CORDOBA OBSERVATORY

By Dr. E. GAVIOLA
Director

THE Cordoba Observatory owes its creation to the happy and trustful collaboration between a great Argentine statesman, President Sarmiento, and a great American astronomer, Director Gould.

During the nineteenth century, astronomy endeavoured to take possession of the sky by making an inventory of its stars. Bessel demanded already in 1822 to know the precise position and brilliance of all stars down to the ninth magnitude. He himself measured the positions of 62,380 stars between 45° north and 15° south. Argelander extended the limits to 80° north and 31° south, adding 50,000 stars. The English astronomer Carrington filled the gap at the north pole. In the south, the American naval officer Gilliss had made many observations at Santiago de Chile (1849–52) between −65° and the south pole, but he died in 1865 and it was uncertain if and when the positions would be reduced and published. (They were in 1895, adding 16,748 stars to the inventory.)

Gould felt it was his mission to fill the great southern gap. He wrote in 1865 to Sarmiento, then Argentine envoy in Washington, asking for permission and protection for leading an astronomical expedition to Cordoba, supported by the friends of science in Boston. Sarmiento offered more than was asked. But the expedition had to be delayed: Gould could not obtain sufficient private funds; the Argentine Government regretted not to be able to help much at that time, on account of having all its energies devoted to the Paraguay War (1866).

Sarmiento became President in 1868 and in the following year Gould was invited to organise an Argentine National Observatory. Gould accepted promptly, ordered a fine 5-in. meridian circle from Repsold in Hamburg, and sailed for Cordoba in 1870. On his arrival he heard that the Franco-Prussian War was delaying his instrument in Hamburg. When it finally arrived in Rosario, it was held up again by a quarantine due to an epidemic of yellow fever. The "Uranometría Argentina", a census of all the naked-eye stars from 10° north to the southern pole, owes its existence to these delays. It contains 7,756 stars down to the seventh magnitude.

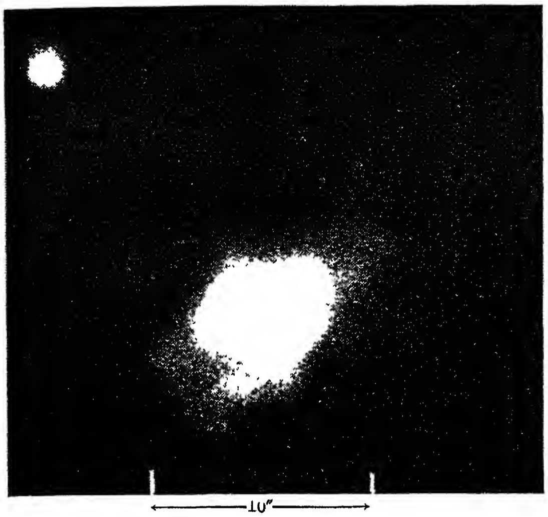
Seventy-five years ago, on October 24, 1871, the Cordoba Observatory was solemnly and officially inaugurated with speeches by President Sarmiento, Secretary Avellaneda and Director Gould.

The planned observations with the meridian circle were begun in September 1873 and continued by Gould until 1885, when he considered his mission in Cordoba fulfilled and returned to the United States. The main fruits of this period were the "Zone Catalogue", published in 1884, containing 73,161 stars between 23° and 80° south and the "Argentine General Catalogue" (1886) of 33,500 southern stars measured repeatedly with the utmost precision. The gap in the southern skies had been closed and the Cordoba Observatory had won a place of honour in the annals of world astronomy.

Under the direction of John M. Thome, the meridian observations continued and led to new catalogues, but the main work of this period (1885–1908) is undoubtedly the monumental "Cordoba Durchmusterung". It contains 613,718 stars between −22° and the southern pole. Thome himself could not finish it. The first three parts were published by him, the fourth was completed by his successor, Charles D. Perrine, in 1914. The fifth was observed and reduced by José Tretter, appearing in print in 1932, twenty-four years after Thome's death.

The Cordoba Durchmusterung contains all the stars down to the tenth magnitude, and many even fainter (to mag. 11·5) observed with a 5-in. equatorial refractor. It is still to-day the basis for the identification of southern stars.

Thome undertook in 1890 to continue the series of catalogues known as the zones of the "Astronomische Gesellschaft" from −22° south. He measured with the meridian circle the positions of 44,000 stars (−22° to −37°) between 1891 and 1900, but did not live to see the catalogues published. They appeared in 1913, 1914 and 1925. The La Plata Observatory has measured and published the zones −47° to −72°.



η CARINÆ. DIRECT PHOTOGRAPH TAKEN AT THE CASSEGRAIN FOCUS OF THE 60-IN. REFLECTOR OF THE CORDOBA OBSERVATORY WITH AN EQUIVALENT FOCAL LENGTH OF 31·5 M. ENLARGED 20 TIMES FROM ORIGINAL. SCALE 10 ARC SEC. = 38 MM. UPPER LEFT: FIELD STAR

The zone $-37°$ to $-47°$ has been reduced lately in Cordoba, and should appear in 1947. The zone $-82°$ to $-90°$ has been re-measured recently by Jorge Bobone with the 190-mm. Repsold meridian circle and is being reduced.

Cordoba has contributed to "La Carte du Ciel" with eight volumes published between 1925 and 1932, covering the zones $-24°$ to $-31°$. The work was begun by Thome but carried out mainly by Perrine.

The need of catalogues of high precision of a limited number of selected stars was met by Meade L. Zimmer, who measured, reduced and published the "First Fundamental Catalogue" in 1929 and the "General Fundamental Catalogue" in 1941. They contain 761 stars reduced to the mean equinoxes of 1900 and 1950 respectively.

Juan José Nissen, the first Argentine director of the Observatory, made an important contribution to the exact determination of the orbit of Eros, as part of the campaign led by the Astronomer Royal of Great Britain for the improvement of the solar parallax. The first places, according to statistical weights attributed to the results, were accorded to two southern observatories—the Cape and Cordoba—among thirty-six throughout the world.

When Perrine came to Cordoba in 1910 the 36-in. Crossley reflector at Lick Observatory and the 60-in. Ritchey reflector at Mount Wilson Observatory were opening new vistas to astrophysics. He obtained ample funds from the Argentine Government; he ordered a 60-in. mounting by Warner & Swasey, moulded glass blanks by St. Gobain, and he built a mechanical and an optical shop in Cordoba. Perrine desired to pioneer in stellar spectroscopy of the south as Gould did in astronomy. But the task of making large astronomical mirrors was beyond the skill of the personnel he could obtain at the time. The 60-in. parabolic mirror was figured finally by Fecker in Pittsburgh in 1939; the Newtonian and Cassegrain secondaries by the optical shop of the Cordoba Observatory in 1941 and 1942.

The 154-cm. reflector was erected in Bosque Alegre, the Astrophysical Station of the Cordoba Observatory, and inaugurated in 1942.

A spectrograph with a dispersion of 40 A. per mm. built in Cordoba, with a Wood grating, makes it possible to take spectra of stars down to the eleventh magnitude. A fast, 'nebular' spectrograph with a 60° quartz prism and $f/1$ Schmidt camera is being built.

Current work consists of the determination of radial velocities in the Magellanic Clouds (Ricardo Platzeck), the discovery and study of variable stars in the same (Martin Dartayet), investigation of spectroscopic binaries (Jorge Sahade), study of η Carinæ and other stars with emission line spectra (Enrique Gaviola), theoretical astrophysics (Guido Beck), search for white dwarfs among stars of large proper motion (Martin Dartayet and David McLeish). Programmes of systematic determinations of radial velocities of southern stars are planned.

During the past seventy-five years astronomy has substantially completed the inventory of the sky. The intense and precise study of particular stars and phenomena, using the most refined methods of theoretical and experimental physics, is now demanding increasingly the attention of the astronomers. Cordoba hopes to be of service also in this new field.

NEW DEVELOPMENTS IN RELATIVISTIC QUANTUM THEORY

By DR. C. MØLLER
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THE ordinary quantum mechanics which, in principle, was completed in the middle of the 'twenties, gives a correct account of a very large number of experimental results. Still, it was from the beginning quite clear that this theory is an approximation to the truth, since it does not satisfy the requirements of the theory of relativity. Non-relativistic quantum mechanics would, therefore, be expected to give correct results only in those cases where the velocities of the elementary particles are small compared with the velocity of light.

However, at that time it was a general opinion among physicists that the adaptation of quantum mechanics to the requirements of relativity was more or less a mathematical question which would not give rise to any physical difficulties. In fact, Dirac was able to develop a relativistic theory of one electron in an external field; and this theory was in very good agreement with experiments also in cases where the velocity of the electron approaches the velocity of light.

Nevertheless, as one tried to give a relativistic treatment of the interaction between two or more elementary particles, one met with a characteristic difficulty which could not be removed in a satisfactory way by any mathematical trick. Since the development of the theory of relativity, the field concept had become of special importance in physics. In order to account for the finite propagation velocity of all forces, which is a fundamental consequence of the theory of relativity, it seemed absolutely necessary to describe the interaction between elementary particles by means of an intermediary field, and this field has to be treated as a special physical system in accordance with quantum mechanics.

This was done in 1929 for the first time by Heisenberg and Pauli in the case of electromagnetic forces

between charged particles. These authors developed a theory which formally satisfies all relativistic requirements of covariance. However, this theory already contained the well-known divergence difficulties which manifest themselves as soon as one tries to use the theory for the calculation of special problems. For example, the theory gives infinite values for the energy in all stationary states of a system of charged particles, and a reasonable physical result can be obtained only after subtraction of an infinite quantity—the self-energy of the particles.

Similar difficulties arise in all quantum field theories; also, for example, in the theory of the so-called meson fields which were introduced by Yukawa in order to account for the forces acting between the nucleons in the atomic nuclei. In order to get reasonable physical results from these theories, one has to have recourse to special assumptions in the application of the formalism. For some time it was hoped that the divergencies were due simply to the mathematical procedure which was applied in the solution of the field equations, and some divergencies certainly are of this origin. However, it can be shown that the field equations themselves implicitly contain infinities from the beginning, so that the divergencies are not all introduced by the method of solving the field equations. This may be seen from an argument by Heisenberg[1]. On account of the commutation rules for the field variables, which contain singular functions of the type of a δ-function, the eigenvalues of a field variable in a definite point in space-time are infinite, in contrast to the mean value of a field variable over a finite region which has finite eigenvalues. Now, in all relativistic field theories the interaction terms in the Hamiltonian contain the product of two, or more than two, field variables at the same point, and the field equations are therefore of the type of differential equations with infinite coefficients.

Thus, the infinities are intrinsic difficulties of all relativistic quantum field theories. It seems that the frame offered by quantum mechanical principles is too narrow and that the difficulties can be removed only by a radical change in these principles. Now it is difficult to imagine any change in the fundamental concepts following from the principle of superposition, that is, the general mathematical scheme describing the relations between states and observables, and the whole transformation theory must be supposed to hold in the future theory also. It is different, however, with the equations of motion, which in the Schrödinger picture are represented by the Schrödinger equation

$$i\hbar \frac{\partial \psi}{\partial t} = H\psi.$$

This equation determines the variation of the physical state ψ in time, if the Hamiltonian operator H is given. In quantum mechanics, the physical system considered is *defined* by H or by the set of all regular solutions of the Schrödinger equation.

Now, it seems very doubtful that in any relativistic theory of the future a Hamiltonian and a Schrödinger equation will exist at all in general. For, if the interaction is introduced in the same way as in the ordinary field theories, the above-mentioned difficulties arise and, if we try to avoid the infinities by introducing in some way a finite particle radius or a minimal length, the symmetry between the space and time variables, following from the theory of relativity, will require the introduction also of a minimal time, and this seems to make a continuous time displacement, such as that given by a Schrödinger equation, impossible. The problem then arises how to describe the experimental results in those cases where the systems considered have no Hamiltonian and, consequently, no Schrödinger equation. In other words, we have to find the quantities which in the future theory will take over the part played by the Hamiltonian and the Schrödinger wave function in quantum mechanics.

In this connexion, Heisenberg[2] has made a decisive step forward in a recent series of papers. In these papers, he tries to single out those quantities of the ordinary quantum mechanics, which may be supposed to represent 'observable' quantities in any future theory, also; for it is clear that the purpose of a theory must be to give relations between 'observable' quantities. Now, it is not always quite simple to say what we mean by an atomic variable being 'observable'. What is directly observed in the laboratory is always a macroscopic quantity, for example, the position of the hands of a measuring instrument, points and lines on photographic plates, etc. In order to draw any conclusions about the values of atomic quantities from these direct observations, we need a theory, and if the theory allows unambiguous conclusions to be made about an atomic variable, this variable is said to be an 'observable' quantity. Strictly speaking, the question whether a definite atomic quantity (like the position of an electron) is observable or not can, therefore, only be decided after the theory has been fully developed.

There are, however, a few atomic variables which are so directly connected with the observations which are made in the laboratory, that they must be expected to be 'observables' in any theory.

(1) In the first place, all the variables of free elementary particles, such as the momentum, kinetic energy, mass, electric charge, etc., must be considered observable; for the ordinary quantum mechanics may be supposed to hold for free particles, since all difficulties come in only through the interaction between the particles.

(2) The cross-sections for all kinds of atomic processes are certainly observable, since most experimental data about an atomic system are given in terms of cross-sections.

(3) The energy values of atomic systems in closed stationary states are also so directly connected with simple observations that they must be considered observables in any theory. They may be determined on the lines of a Franck–Hertz experiment, or by observation of the energies of emitted particles. All spectroscopic determinations of atomic energies are of the last-mentioned type and, in the case of radioactive nuclei, the fine structure of emitted α-particles allows immediate conclusions about the energy levels of the rest nuclei.

(4) In the last-mentioned cases, the mean life-time or the decay constants of the radioactive nuclei must be considered observable.

If we can develop a theory which contains only relations between the variables (1)–(4), and enables us to calculate these variables in special cases, this theory must be considered wholly satisfactory from a physical point of view, since it allows us to give definite answers to all such questions in which the experimental physicist may be interested.

However, in ordinary quantum mechanics other quantities in addition to the quantities (1)–(4) are

considered observable. According to this theory, one may, for example, also ask for the value of the probability that two colliding particles have a given small mutual distance, r, and this probability is given by the absolute square of the value of the wave function corresponding to this small value of r. Such a question can, however, never be of direct interest to the experimental physicist, since his experiments only give cross-sections, that is, the probabilities for large distances r. We may therefore expect that only the asymptotic values of the wave functions for large values of r will enter directly into the future theory, and not the wave function for all values of r.

Now, Heisenberg noted that the asymptotic expression for the wave function in ordinary quantum mechanics for any kind of system is determined by a certain matrix S which he called the 'characteristic matrix'. In quantum mechanics the matrix S can be calculated when the Hamiltonian of the system is given. When S is given, the asymptotic behaviour of the wave functions and all kinds of cross-sections are determined, but not the probabilities for the particle being separated by small distances. Heisenberg, therefore, made the assumption that the characteristic matrix S in a future theory will take over the part played by the Hamiltonian and the wave functions in ordinary quantum mechanics, and that the atomic systems in the new theory will be defined by S and not by H or ψ.

It may now be shown that all the quantities (2)–(4) may, in fact, be calculated if we only know S; but such questions as to the probabilities of the particles being separated by definite small distances r cannot be answered unambiguously when we know the matrix S only. Thus, the new theory in which S, but not H, in general is given, means a new step forward away from the classical theory, which tried to give a detailed picture of the physical process.

In order to develop a theory on these lines, we shall in the first place try to find the general conditions which the characteristic matrix satisfies quite independently of the structure of the atomic system considered. To find these general conditions, we make the assumption that all general conditions which the characteristic matrix satisfies in quantum mechanics, independently of the form of the Hamiltonian, will hold also in the cases where no Hamiltonian of the system exists. In this way, it is easily shown[2,3] that the characteristic matrix is always a unitary matrix, namely,

$$S^\dagger S = S S^\dagger = 1$$

where $S^\dagger$ is the Hermitian conjugate of S.

Further, using the connexion between the matrix elements of S and the cross-sections, it is easily proved[3] that S is an *invariant* matrix; that is, if $\bar{S}$ and S are the characteristic matrices of the same atomic system in two arbitrary Lorentz frames of reference, we have simply

$$\bar{S} = S.$$

This means that S has a meaning quite independently of the Lorentz frame which we use in our description. This simple transformation property of the characteristic matrix brings about a considerable simplification in the description of atomic phenomena as compared with the quantum mechanical description, in which the fundamental matrix, the Hamiltonian, has rather complicated transformation properties under Lorentz transformations.

If the characteristic matrix is given, one of the main problems is to find a representation in which S is in the diagonal form. The analogous problem in quantum mechanics, to bring H into the diagonal form, is solved if we know a complete set of commuting constants of the motion (J), that is, a sufficiently large number of commuting variables J which commute with H also. In the same way, our problem is to find a complete set of commuting variables (α) satisfying the equations

$$\alpha S - S \alpha = 0.$$

In a representation where the α's are in the diagonal form, S will also be in diagonal form, and the eigenvalues S^0 of S will be functions of the eigenvalues (α^0) of the α's, that is,

$$S^0 = S(\alpha^0).$$

Now, the total kinetic energy always commutes with S and, if the α's also commute with W, we may take W as a member of the complete set of variables commuting with S. In this case, the α's may be called constants of collision, since they may be shown to have the same values (or mean values) before and after the collision. However, they need not have constant values during the collision and, for a system which has no Hamiltonian, it is meaningless to speak of the mean value of an α during the collision. The total kinetic energy W, for example, is a constant of the motion, since W has the same value before and after the collision; but W is, of course, not a constant of the motion. The constants of collision thus play a similar part in the new theory to the constants of motion in quantum mechanics.

In quantum mechanics the form invariance of H under rotations in three-dimensional space gives us a set of three constants of the motion, that is, the components of the total angular momentum. In the same way, the invariance of S under the larger group of Lorentz transformations may be used to find at once a set of six constants of collision

$$(\alpha) = (K_x, K_y, K_z, W, L, m) = (W, \beta)$$

where K and W are the total linear momentum and kinetic energy respectively, while L and m are two variables which, in the system of reference where K is zero, are identical with the magnitude of the total angular momentum and the component of the angular momentum in a definite direction, respectively[3].

If the characteristic matrix S is given, all cross-sections can be determined immediately from S, but if, as claimed by Heisenberg, the matrix S is to give a complete description of all 'observable' quantities for any atomic system, the quantities (3) and (4) must be derivable from S also. (In his papers quoted above, Heisenberg only considered the quantities (2) and (3).) The clue to the solution of these problems was given by Kramers[2], who remarked that the Schrödinger wave function ψ_{W^0} belonging to a continuous energy value W^0 in all physically important cases in ordinary quantum mechanics is an analytical function of the variable W^0. By the process of analytical continuation, ψ_{W^0} may then be given an unambiguous meaning for complex values of the variable W^0, as well as for real values W^0 smaller than the minimum value W_m^0 of the energy in a continuous state. In any event, ψ_{W^0} will be a solution of the Schrödinger equation, but it is not possible to give a physical interpretation of this solution for all values of W^0. Consider, for example, the case of a real $W^0 < W_m^0$: then the asymptotic expression of ψ_{W^0} for large values of the relative distance between the particles consists of two terms, the first of which

vanishes for large distances, while the second term increases exponentially with increasing distances. The last term contains an eigenvalue S^0 of the characteristic matrix as factor. Thus, ψ_{W^0} will be an eigenfunction corresponding to a closed stationary state only for those real values of $W^0 < W^0_m$ which make S^0 equal to zero.

In this way, the energy values in the closed stationary states are determined as the zero points of the eigenvalues S^0 of S on the real axis in the W^0-plane. In the same way, it may be shown[4] that the singular points of S^0 in the lower half W^0-plane determine the energies and decay constants of the system in radioactive states, where the system can emit one of its particles. In fact, these quantities are determined by the real and imaginary parts of those values of W^0 (in the lower half-plane) where S^0 has a pole.

It thus seems that all experimental results may be described by means of Heisenberg's characteristic matrix without making use of the wave functions of ordinary quantum mechanics, and it seems possible on these lines to get a relativistic treatment of atomic phenomena, which does not contain the difficulties inherent in all relativistic quantum field theories of the Hamiltonian form.

[1] Heisenberg, W., Report to the Solvay Congress which was planned to take place in 1939.

[2] Heisenberg, W., "Die 'beobachtbaren' Grössen in der Theorie der Elementarteilchen", (i) *Z. Phys.*, **120**, 513 (1943); (ii) *ibid.*, **120**, 673 (1943); (iii) and (iv) *ibid.* (1944–45).

[3] Møller, C., "General Properties of the Characteristic Matrix in the Theory of Elementary Particles, I", *D. Kgl. Danske Vidensk. Selsk. Mat.-fys. Medd.*, No. 1 (1945).

[4] Møller, C., "General Properties of the Characteristic Matrix in the Theory of Elementary Particles, II", *D. Kgl. Danske Vidensk. Selsk. Mat.-fys. Medd.*, No. 19 (1946).

HETEROGENESIS AND THE ORIGIN OF VIRUSES

THE name heterogenesis has been used to describe the derivation of a living thing from something unlike itself. In discussions of this subject many years ago—whether eels could be born of mud, or maggots and bacteria from putrefying matter—it was something non-living from which organisms were thought to have sprung. Later the argument took a different turn and there was speculation as to whether things as small as viruses might not be derived from some constituent of the complex cell-structure of higher animals or plants. This new aspect of the heterogenesis controversy formed the subject of a discussion at the British Association in 1931, opened by Sir Henry Dale, and the matter has now been debated again by the Society for General Microbiology, meeting at Leeds on July 23.

There are two main conceptions of the origins of viruses. Most workers on animal viruses have maintained that they resemble degraded bacteria which have lost their structural and biochemical complexity in the process of becoming adapted to a specialized parasitism. In the end, in Laidlaw's words, "they live a borrowed life", depending on the host cell for the enzymatic activity necessary for their multiplication.

Alternatively, it is argued, some self-replicating cytoplasmic constituent of a complex cell, such as a plasmagene, may become capable of multiplying when transferred to a new environment such as another cell and acquire an individuality of its own. Such an agent, being complex, would presumably tend to vary; and being variable and self-replicating, would become subject to the laws of natural selection and acquire the status of an independent organism.

All speakers at the discussion agreed that the degraded parasite hypothesis was almost certainly true as regards the animal viruses, at least the larger ones. As Dr. F. M. Burnet of Melbourne pointed out, the student of infectious disease has to assume that view from a pragmatic angle; to the epidemiologist many viruses behave so very much like organisms in general. Dr. G. M. Findlay further noted that occurrences of apparently spontaneous origin of animal viruses were almost unheard of. Quarantine was of undeniable efficiency in keeping out such viruses as rabies, foot-and-mouth disease and rinderpest; these gave no evidence of arising *de novo* in fresh hosts.

A difficulty arises in regard to the bacteriophages—or as they are coming to be called, bacterial viruses—though Dr. A. Felix adduced reasons for refusing to consider them as being viruses at all. The trouble is to imagine, if the degradation hypothesis is applicable, from what the phages could have been degraded. Here Dr. Burnet produced a new and fascinating theory: that they were the direct descendants of precellular stages in the evolution of living forms; after the first bacteria were evolved, such primitive precellular creatures were at a great disadvantage and only those which adopted a parasitic habit within the dominant bacteria were able to survive.

The tailed tadpole-like form which the electron microscope reveals for many bacterial viruses certainly seems to set these apart from other viruses. Indeed, there was a general feeling throughout the discussion that a decision as to the origins of viruses should be taken on their merits for each group, animal, plant and bacterial viruses, and that a tendency for generalization to be too inclusive should be resisted.

The animal pathologists were mainly agreed that the viruses in their field were degraded organisms, but some of them made reservations as regards tumour viruses. Dr. Peyton Rous, whose presence was much welcomed, referred to induction of neoplasms of all sorts in mouse embryo tissue exposed to methylcholanthrene. Could we believe, as seemed to be forced on us by these findings, that a virus was present in all the cells and handed down by heredity? The tumours produced involved all sorts of tissues and were of most varied histological types. Could each type be due to activation of a different virus? In the case of fowl tumours, the filterable agents were highly specific, each producing a tumour of one precise histological type. The original tumours from which the infective filtrates were derived had no obvious epidemiological connexion with another similar type of tumour. Both Dr. Rous and Dr. A. Haddow leaned to the heterogenetic explanation of the origin of some tumour viruses. But the latter pointed out important distinctions to be drawn among the tumour viruses. That causing rabbit papillomata—from which cancers may derive—behaved like a degraded organism. The Bittner mouse cancer agent also acted like an extrinsic agent but rather less characteristically than did the papilloma virus. The story of the fowl tumour viruses, however, rather suggested the doings of agents of intrinsic origin.

Dr. C. H. Andrewes was reluctant to draw a distinction between tumour viruses and others. He

felt that latency and activation by an appropriate stimulus were the characteristic features of the behaviour of many, perhaps most, viruses in their natural hosts. He suggested that with some viruses parasitic adaptation to the host might become so perfect that the individuality of the virus was lost in that of the host cell. This might be permanent ; but if the change was a reversible one, viruses brought to light would have an apparently heterogenetic origin. There was some evidence, as in insect viruses and Rickettsiæ, of transmission through the egg.

There was less tendency for speculation among the students of plant viruses, exemplified by Dr. F. C. Bawden. He preferred to "wait and see", but clearly had a weakness for heterogenesis. Virus-like proteins might be normal constituents of some plants, but our present methods of detecting them would not be nearly delicate enough—unless the object of our study was self-reproducing in another environment.

Along with speculation on the origins of viruses must go curiosity as to what they look like. The metal-shadowed electron micrographs which Dr. R. W. G. Wyckoff showed (see *Nature* of March 2, p. 263) caused much interest and pleasure. The bean mosaic particles, lining up in orderly array to form a crystal, caused a spontaneous burst of applause ; while pictures of influenza virus existing as small spheres or, unless our eyes deceived us, as long filaments, left us in awed wonder.

OBITUARIES

Dr. Arthur W. Rogers, F.R.S.

On June 23 there died at Cape Town, at the age of seventy-four, one to whom South Africa owes much in regard to geological discovery, description and application. A. W. Rogers was born at Bishops Hull, Somerset, and educated at Clifton College and Christ's College, Cambridge—of which he was later elected an honorary fellow—and also studied at the University of Heidelberg. In 1896 he became assistant geologist to the Geological Commission of the Cape of Good Hope, director of the Commission in 1903, and director of the Geological Survey of the Union from 1916 until his retirement in 1932. His thirty-six years of sterling service with the Government were divided equally between the Cape and Transvaal provinces.

Closely associated in the field at first with his colleague, Prof. E. H. L. Schwartz, largely within the picturesque south-western corner of the Cape with its magnificent exposures of folded strata, he was able by 1905 to publish "An Introduction to the Geology of Cape Colony", the first text-book of its kind for southern Africa, and a work of considerable merit. In it were set forth the main tectonic lines, stratigraphy, palæontology and history of this interesting land with its many pre-Cambrian systems, Carboniferous glacials, prolific Permo-Triassic vertebrates and mesozoic dolerites. During the next decade he carried investigation far to the north—to the border of the Kalahari and German territory—describing little-known pre-Cambrian groups or discovering new ones, such as the crocidolite-bearing jaspers, the Numees tillite, Ongeluk tillite, magmatic copper-bearing eruptives and melilite-basalts.

In the Transvaal his main work lay in the mapping of the Heidelberg gold-fields, during which the glacials of the Witwatersrand beds were first recorded. Administrative duties greatly interfered with his output of purely scientific work. Under his able direction, however, a high standard was achieved by the Geological Survey, and numerous maps and memoirs issued, not a few of them of high economic importance.

Attracted, like so many others, by the vast Kalahari and its queer siliceous and calcareous rocks, he was able to cross its heart as well as inspect its borders, and contributed two illuminating addresses on the solid and surface geology of that sand-strewn region.

Always interested in the finer structure of substances, he developed upon retiring to the Cape in 1932 a still keener interest in the microscopical and microchemical examination of the sedimentary rocks, a study which he pursued the more constantly after 1938, when cardiac disturbances had debarred him from further field work. To many of us such minuter researches proved helpful indeed.

His writings were numerous and varied : for the most part accounts of regional geology appearing as departmental reports or in yearbooks, or else as papers based thereon, though none was of monographic size. His most important works are "The Geology of the Country around Heidelberg", his contribution to the "Handbuch der Regionalen Geologie : The Union of South Africa" (1929) and his fascinating history of "The Pioneers in South African Geology and their Work" (1937), in which so much interesting geological as well as biographical information was so meticulously recorded for posterity. His presidential addresses cover a wider field and range in their subjects from past climates to the evolution of river systems and 'pans'. Only just recently did he complete a description of the Diatom floras of the diatomaceous deposits of the Union in collaboration with L. E. Kent, intended for Memoir No. 42 of the Geological Survey, a research on which he had been long engaged.

In all, Dr. Rogers contributed both abundantly and nobly to our geological and geographical knowledge of a wide terrain, which the writer indeed regards as one of the key regions of the earth.

Connected with many learned societies, he was elected a fellow of the Royal Society of London (1918), the Geological Society of London (1896) and Royal Society of South Africa, as well as honorary fellow, member or correspondent of others. Rogers was president of the Geological Society of South Africa (1915), of the South African Association for the Advancement of Science (1922), of the International Geological Congress (1929) and of the Royal Society of South Africa (1934–35).

His awards were numerous : the Bigsby Medal (1907) and Wollaston Medal (1931) of the Geological Society ; South Africa Medal (1913) of the South African Association for the Advancement of Science ; Scott Medal (1931) of the Biological Society of South Africa, and Draper Memorial Medal (1936) of the Geological Society of South Africa.

Rogers will always be remembered for his geniality, readiness to discuss or guide, scrupulous attitude towards the work or views of others, and honesty of purpose. His outlook was, however, coloured by some conservatism. Throughout, he was the scientific worker pursuing his subject for its own sake, and perhaps for that reason the grander problems of the African continent do not seem to have gripped him. Having been closely associated with Arthur Rogers over many years, the writer feels that a noteworthy geologist has been lost to the world.

Alex. L. du Toit

Dr. Louis Martin

By the death of Dr. Louis Martin on June 13, one of the last remaining links with Pasteur has been severed. Martin was born on September 20, 1864. In 1892, when he was a young doctor at the hospital for children's diseases in Paris, he became associated with Roux in a remarkable series of investigations which showed the immense possibilities of the newly discovered antitoxin for the control and treatment of diphtheria. The results of their work were communicated at an International Medical Congress at Budapest in 1894 by Roux, Chaillou and Martin in a paper the importance and high quality of which has been recognized for half a century. This was Martin's introduction to diphtheria, a subject in which his interest remained unabated to the end of his life. He was appointed to the staff of the Pasteur Institute in 1892, where he remained for the rest of his working life, occupying positions of increasing importance and finally becoming director in 1934. He made notable contributions to the bacteriology of the diphtheria bacillus and closely related organisms, devised a culture medium for the production of diphtheria toxin which is widely used to-day, extended his researches on the prophylaxis and treatment of diphtheria, and studied the problems presented by the 'carrier'. For many years he was responsible for the production of the antitoxins and antisera required in France, and later he found solutions to the technical and administrative problems created by the enormously increased demand for these materials during the First World War.

Martin was also interested, and experienced, in public health problems and in the construction and organisation of infectious diseases hospitals. His advice was constantly sought by the State Department and by municipalities concerning the control of epidemics; and the Pasteur Hospital, which Martin served since its establishment in 1900, gave him the opportunity for studying, under what were then novel conditions, the medical care and nursing of cases of infectious disease. With Brouardel he wrote a treatise on hospital organisation and the prophylaxis of infectious diseases, which is a standard work on this subject in France.

In 1914, Martin became vice-president of the Society of Biology and, in later years, president of many learned societies. In 1919 he became a member of the Academy of Medicine and in 1937 he was elected to the Academy of Sciences. Martin's somewhat forbidding appearance and brusque manner hid a warm, kind and generous nature. He gave a lifetime of high endeavour to the service of science, to France, and to the Institute he loved so well.

Percival Hartley

Mr. G. H. J. Adlam, O.B.E.

Mr. G. H. J. Adlam, editor of the *School Science Review*, died suddenly on July 30. With his passing a great landmark has gone, for he alone of the officers of the Science Masters' Association was re-elected year after year, so that members came to look upon him as a permanent pillar of the Association. His was the thought that first suggested the *School Science Review* and his the guiding hand that led it to success. As time went on, zeal for the welfare of the *Review* grew upon him and gripped him more and more until it became his ruling passion. When at the age of sixty-seven he retired from his school duties, having with indifferent health courageously carried on during the War, he looked forward to his leisure to make the *Review* even better. Already in his hands the 1919 booklet of thirty-two pages had in a few years become the largest and most influential journal of school science in Great Britain, if not in the world. Undoubtedly Adlam did more for the betterment of school science than any man of his generation: the value of his work is incalculable. Such an achievement could not pass unnoticed and in 1934 Adlam was awarded the O.B.E. Later, in 1941, he became president of the Science Masters' Association.

Adlam was educated at Wells Cathedral School and Wadham College, Oxford. He graduated with first-class honours in chemistry, and later obtained his B.Sc. for research work on the water component of systems of hydrated salts. He was the editor of the Science Masters' Association publications and the author of some widely used text-books of chemistry. After a varied teaching experience, he settled down at the City of London School, where for many years he was in charge of the science.

"Joe" Adlam, shy and kindly, was in school and on committee an admirable colleague, sage in counsel and sound in judgment. At this critical time in educational affairs his advice and lead will be sorely missed. Qualified as a man of science, he was also an accomplished English scholar, with a rich humour and a rare aptitude for finding the appropriate word. To many a diffident young author he was extraordinarily kind, suggesting better arrangements of his subject-matter and not infrequently re-writing an entire article. In all his activities, his standards were high. He had a dread of losing grip and rusting away; but he died as he wished, in the midst of useful work —he had just completed the third volume of Physics in the Science Masters' Book.

All who knew Adlam will lament his death and extend their sympathies to his widow, formerly Florence Lavinia Chun. A charming hostess and capable housekeeper, she shared his enthusiasm for his favourite recreation—the cultivation of his rock plants—and did much to cheer the evening of his life.

G. Fowles

Dr. L. B. C. Cunningham

Dr. Leslie Bennet Craigie Cunningham died at Harrow on August 31 at the age of fifty-one. Although seriously ill for a lengthy period prior to his death he continued, until the last few weeks, to evince the keenest interest in the research problems of air armaments to which his life's work was devoted.

Born of Scots parentage, Cunningham was educated at Edinburgh Academy and Sedbergh School. His career at the University of Edinburgh was interrupted by the First World War, in which he was commissioned in the King's Own Scottish Borderers and later transferred to the Royal Engineers (Signals Service). On the completion of his studies at Edinburgh he was appointed as an education officer in the R.A.F. and served at No. 1 Air Armament School at Eastchurch and later Manby. In this post his work ranged over the whole theory of air armament both in instruction and research. In 1931 the two-year advanced armament course of university standard was inaugurated under his technical direction, and all senior present-day R.A.F. armament officers were at one time Cunningham's pupils, many

consulting him regularly throughout the Second World War. During this period he was awarded the Ph.D. of the University of Edinburgh for his work on bomb ballistics.

At the outbreak of the Second World War, Cunningham was appointed by the Director of Scientific Research, Air Ministry, to lead a small body of research workers in the development and application of a mathematical theory of air combat which he had earlier produced. The scope of the work of this group, called the Air Warfare Analysis Section, and its strength, expanded rapidly during the War until it eventually covered a very wide field, ranging from the geodetic work associated with the blind-bombing tactics of the R.A.F. to the statistical theory of aim-wander in aerial gunnery.

In 1945 Cunningham was elected a fellow of the Royal Society of Edinburgh. Security restrictions unfortunately prevented the publication of much of his work, but a joint paper with W. R. B. Hynd on the application of the theory of random processes to air-warfare, read recently before the Royal Statistical Society, indicates the trend of much of his recent work.

Cunningham was prevented by his death from taking up a high appointment at the Royal Aircraft Establishment, Farnborough, and his loss will be keenly felt throughout the sphere of air armaments. He will be remembered with affection by all who worked with him.

E. C. CORNFORD

WE regret to announce the following deaths:

Sir Carruthers Beattie, during 1918–37 vice-chancellor and principal of the University of Cape Town, on September 10, aged seventy-nine.

Sir James Jeans, O.M., F.R.S., on September 16, aged sixty-nine.

Nikolai Morozov, honorary member of the Academy of Sciences of the U.S.S.R., known for his general writings on scientific topics, on July 13, aged ninety-two.

NEWS and VIEWS

Engineering at Edinburgh: Prof. R. N. Arnold

PROF. R. N. ARNOLD has been appointed to the regius chair of engineering in the University of Edinburgh. Prof. Arnold completed a brilliant studentship record by graduating at the University of Glasgow in 1932 with first-class honours, and followed this directly with a period on research, which qualified him for the associateship of the Royal Technical College and won the principal College research award. Appointment to a Senior Caird Scholarship then followed, and with this, he went to Sheffield to continue his work on engineering materials in Prof. Lea's laboratory. This phase of his research career was notable for work on embrittlement, the theme of several important papers and the subject of his thesis for the Ph.D. degree. In 1934 he accepted appointment to a Commonwealth Fund Fellowship and spent the two succeeding years at the University of Illinois. His work there was marked by a significant change from the more static type of materials investigation to the dynamical questions of impact and vibration; and his later publications have demonstrated his interest and power in this field.

On his return from Illinois in 1936, Dr. Arnold was appointed to a lectureship in the Department of Civil and Mechanical Engineering in the Royal Technical College, Glasgow, where in addition to a wide range of teaching, he took a prominent part in the special investigations conducted by the department. His work on the topical engineering problem of the 'singing propeller' was particularly valuable, and the papers published by him and his colleagues on this subject aroused considerable attention and gained the Gold Medal of the Institute of Engineers and Shipbuilders in Scotland and the Thomas Lowe Gray Prize of the Institution of Mechanical Engineers. In 1941, Dr. Arnold joined the senior staff of the Metropolitan-Vickers Electrical Co., and while there was engaged on many important investigations. Later papers on some of these have made him widely known as a main authority on such diverse lines as machine tool dynamometry and gyroscopic stabilization problems. The latter was the subject of his thesis for the Glasgow D.Sc., which gave a fine demonstration of analytical and experimental powers, adequately and successfully combined with inventive faculty and design capacity. He was appointed professor of engineering at University College, Swansea, in 1944, and leaves this position to succeed the late Sir Thomas Hudson-Beare at Edinburgh. Scottish engineering will welcome his return. He brings a fine teaching experience and real gifts of exposition to the instruction of its students, and a proved and polished research power to aid its development.

Geology at University College, London: Prof. S. E. Hollingworth

DR. S. E. HOLLINGWORTH has been appointed to the Yates–Goldsmid chair of geology in University College, London. On leaving Cambridge, Dr. Hollingworth joined the Geological Survey in 1921 and went to the Cumbrian unit then based on Whitehaven. He took part in the survey of the Whitehaven, Gosforth, Cockermouth and Brampton sheets. In Whitehaven and Gosforth he was concerned mainly with Borrowdale rocks and with the Ennerdale Granophyre, but had some Carboniferous rocks with hæmatite. In the Cockermouth Sheet he was allotted the area including the Carrock Fell Complex, made classic by Harker, the greisen mass (with tungsten deposits) of the Skiddaw Granite and the metamorphic aureole of Skiddaw Slates, the Eycott and the northern area of Borrowdales with the Caldbeck mining field, mainly derelict but including the barytes deposit of Potts Ghyll. Much of this work is as yet unpublished, but marks an advance on that of previous workers. In the Brampton area he was concerned mainly with Lower Carboniferous strata and Triassic rocks with gypsum. Here he became particularly interested in drift deposits which led to his paper on glaciation in Western Edenside (*Quart. J. Geol. Soc.*, p. 281, 1931), which was accepted for D.Sc. London. On the dispersal of the Cumbrian unit, Dr. Hollingworth was sent to the Droitwich area, mainly on Trias, and later to that around Cambridge, with its widespread Drift and Recent deposits. At the outbreak of war it was essential that assistance from the Survey should be forthcoming on home ore deposits,

and Dr. Hollingworth was chosen as one of the team selected for the Jurassic iron ores, when again he did excellent work. It will be seen that in his Survey career Dr. Hollingworth has gained considerable experience on a variety of rocks and minerals in various fields. Moreover, he has been ever ready to follow up aspects arising from Survey work which could not be included in the official programme. All this should prove invaluable at University College.

Morbid Anatomy in the University of London: Prof. Dorothy Russell

Dr. Dorothy S. Russell, recently elected professor of morbid anatomy in the University of London and director of the Bernhard Baron Institute of Pathology at the London Hospital, was born at Sydney, Australia. Coming to England as a child, she went from the Perse High School for Girls to Girton College, Cambridge, and passed Part I of the Natural Sciences Tripos (Class 1). A Gilchrist Studentship gave her another year at Cambridge. She entered the London Hospital in 1919, took the Conjoint Diploma in January 1922, and later became M.D. Lond. (University Medal), M.A. Oxford (by decree), Sc.D. Camb. (for published work) and M.R.C.P. London (by by-law 123). She was the first woman awarded the John Hunter Medal of the Royal College of Surgeons (1934). After a year as pathology assistant in the Institute (1922–23) she became a Junior Beit Fellow. Her research, "A Classification of Bright's Disease", was made a Special Report by the Medical Research Council. Then as Rockefeller Medical Research Fellow she divided a year in the United States between Prof. F. B. Mallory and Dr. Wilder Penfield. She then worked in the Bernhard Baron Institute with Sir Hugh Cairns with grants from the Medical Research Council, to the scientific staff of which she was appointed in 1933. She worked at Oxford during the War, returning to the Institute in October 1944.

Of Prof. Russell's numerous publications the most striking perhaps are the study of gliomas by tissue culture with the late Dr. J. O. W. Bland, and the cinematograph demonstration of the living cells with Dr. Bland and the late Dr. R. G. Canti. By culture she also determined the true nature of previously doubtful gliomata. Her work on the pituitary gland is most important. Her experimental work at Oxford proved of great practical value to the troops. Her publications include papers upon general morbid anatomy, in which she has always taken an active interest.

Imperial College of Tropical Agriculture: Mr. H. J. Page, M.B.E.

Mr. Harold James Page has been appointed principal of the Imperial College of Tropical Agriculture in succession to Mr. O. T. Faulkner, who retired on August 31. Mr. Page, who will take up his new duties early in 1947, was educated at Southend High School and at the University of London, where he held three scholarships and was prizeman in organic chemistry and gold medallist in physiology; in Berlin under Prof. Willstätter and in Paris at the Institut Pasteur. During 1920–27 he was chief chemist and head of the Chemical Department at Rothamsted Experimental Station. On leaving Rothamsted he became head of the Research Laboratories at the Imperial Chemical Industries Agricultural Research Station at Jealott's Hill and eventually controller of agricultural research there. In 1936 Mr. Page was appointed director of the Rubber Research Institute of Malaya, and during the Second World War was interned in Sumatra for three and a half years.

The Library Association

The University and Research Section of the Library Association held its tenth week-end conference at Winchester College during September 6–9. At the general meeting of the Section, Mr. G. Woledge, librarian of the British Library of Political and Economic Science, London School of Economics, outlined the proposals for a survey of the specialist bibliographical resources of the country. Libraries which already possessed the nuclei of specialist collections would be encouraged to develop those collections so far as their means allowed; and the survey would cover Government, university, research and the larger municipal libraries alike. The status of librarians in Government departments was the subject of a discussion to which two librarians from Government libraries made valuable contributions. It was urged that trained librarians should be employed in all departmental libraries, and that, in order to attract individuals with professional qualifications, a new librarian grade should be introduced in the Civil Service, analogous to those already established for other professional appointments. In this way a library post would not merely be a stepping-stone to a higher appointment in a different branch of the department, but would offer adequate prospects of promotion within its own field, and so result in an increased efficiency in Government departmental libraries.

Mr. A. E. Cummins, librarian of the Chemical Society, opening a discussion on the procurement of foreign publications for British libraries, outlined the conditions at present obtaining in Germany and contrasted sharply the far-sighted policy adopted by the Americans and Russians with the meagre results obtained by ourselves. Mr. K. Garside, deputy librarian of University College, London, viewed with concern the opportunities already lost and emphasized particularly the urgency of procuring important works published in Germany since the end of the War; the Library of Congress Mission has been empowered to cover the post-war field on behalf of the libraries of the United States. Mr. J. S. G. Simmons, deputy librarian of the University of Birmingham, pointed to the need for ensuring a regular flow to Great Britain of Russian publications, and especially of bibliographical reference material. The Section discussed the priorities to be allotted to the various categories of libraries in the distribution of war-time publications that were in short supply, and expressed the view that, where only a single copy of a work was available, that copy should be placed in a library where it would be readily accessible to all who had cause to consult it.

Industrial Relations and the Trade Unions

A broadsheet "Inside the Unions" (No. 249) recently issued by Political and Economic Planning is of some interest to scientific workers as a factual study of a movement towards which some professional associations of scientific workers are attracted. It is also of value in its bearing on the question of industrial relations and the causes of the rift between rank and file and the branch secretaries and national leaders indicated by a number of unofficial strikes.

The broadsheet analyses trade union activity at three levels, and directs attention to the clearly marked gradation of attitude running through the union structure: the rank and file, suspicious of employers and of those who put their point of view, deceptively quiescent for long periods, ill-versed in the difficulties of negotiation; the more experienced and consistently active group in a branch, conscious of difficulties, anxious not to imperil the claim of the branch to meet employers as a responsible body, yet militant and conscious of pressure from below, often critical of apparent inertia at the national level; and finally, the national officials concerned with the main issues of policy, weighing the balance of forces and expediency, trying to form and execute a broad strategy for the advance of the union, embarrassed by manifestations of irresponsibility by the branches or rank and file which may prejudice much greater issues. An important feature of the broadsheet is its analysis of attendance and voting in trade union branches and the attempt to correlate both with the size of the branch. The division between 20 per cent of regular active attention to union business and the 80 per cent of apparent apathy but episodic action goes back for nearly a hundred years in the union structure. This attempt to bring a controversial subject within the ambit of scientific analysis is noteworthy, not only for the reasons already given, but also as illustrating an approach which should be much more widely applied in the study of democratic institutions.

Observations at the Ebro Observatory

SERIES A of the *Boletín Mensual del Observatorio del Ebro*, 31, Nos. 1–9 (1943), deals with heliophysics, meteorology and seismology. Under the first are included the observations of sunspots, which are classified under five different types, definitions of which are supplied. Thus, type 1 includes a group of one or more scattered spots; type 2 a formation of two spots; type 3 a string of spots; type 4 isolated spots; and type 5 an irregular group with large spots. A table gives a comparison of solar activity in the sectors north-east, south-east, south-west and north-west. 'Meteorology' contains tables showing the atmospheric pressure, temperature, relative humidity, rainfall, hours of sunshine, etc. The third portion consists of short tables in which, among other items, are included the period, amplitude, time of occurrence and observations of earthquakes, and information, where such is available, regarding the epicentre. Series B deals with terrestrial magnetism and electricity and with atmospheric electricity for the months October, November and December 1936. This series consists almost entirely of tabular matter dealing with the general characteristics of each month, the maximum amplitude of oscillation of the compass, and the mean values for each month, and also the atmospheric potential gradient.

Bristol City Musuem and Art Gallery

THE annual report for 1945 of the Committee of the Bristol City Museum and Art Gallery notes the separation (proposed in 1944) of museum and art gallery services, the former under the direction of Dr. F. S. Wallis, and the latter under the direction of Mr. H. W. Maxwell. This appears to be a progressive movement on the part of the Committee, and the policy will be highly favourable for the future activities of both institutions. Although for the present the City Museum and the City Art Gallery will remain in the Art Gallery buildings (those of the Museum having been badly damaged during the War), the Committee has under consideration a long-term policy which includes the future provision of new sites for both art gallery and museum purposes. As in the case of other 'bombed-out' museums, the museum in Bristol has been faced with many difficulties, but numerous temporary exhibitions of topical and educational interest, together with 'museum competitions' held in collaboration with the Bristol Holidays-at-Home Committee, have helped to bridge the gap left by lost exhibition galleries. These, besides attracting large numbers of visitors, have been, without doubt, of considerable public value. The re-opening of the Georgian House and the resumed use of the Red Lodge for the annual exhibition of paintings and other functions are also reported.

Locating High-frequency Cable Faults

IN a paper on new methods of fault location, read by F. F. Roberts in London before the Institution of Electrical Engineers, it is pointed out that normal fault-locating procedures become impractical in certain conditions, either for purely technical reasons or on account of the loss of service-time involved. The author first summarizes a theoretical investigation of the possibilities of applying pulse and frequency-modulation methods to this problem on wide-band coaxial telephone cables, and then describes a practical fault-locator employing D.C. pulses. The problem is contrasted with that of radar, and the factors controlling the choice of the transmitted wave-form and those limiting the accuracy of location obtainable are then discussed. The fundamental requirements of a frequency-modulation system are examined in some detail, and it is concluded that, although a frequency-modulation instrument would be attractive in certain circumstances, the practical advantage lies with the pulse type of fault-locator owing to the clarity and reliability of its indications when more than one fault is present. The D.C. pulse instrument described has been in use for some time, and faults on coaxial cables have been located within 1 per cent of their true distances at ranges up to ten miles.

1851 Exhibition Research Scholarships

OVERSEAS Science Research Scholarships for 1946 have been awarded by the Royal Commission for the Exhibition of 1851 to the following: *Canada:* on the recommendation of McGill University, Montreal, to Dr. J. T. Edward for research in organic chemistry at the University of Oxford; on the recommendation of Queen's University, Kingston, to G. R. G. Lindsey for research in physics at the University of Cambridge; on the recommendation of the University of Toronto to C. A. Barnes for research in physics at the University of Cambridge. *Australia:* on the recommendation of the University of Melbourne to A. M. Clark for research in zoology at the University of Cambridge; on the recommendation of the University of Sydney to E. E. Salpeter for research in theoretical physics at the University of Birmingham. *New Zealand:* on the recommendation of the University of New Zealand to H. A. Whale for research in physics at the University of Cambridge; and A. V. Jones for research in physical chemistry at the University of Cambridge. *South Africa:* on the recommendation of the University of the Witwatersrand to P. R. Levy for

research in organic chemistry at the University of Oxford. *Eire:* on the recommendation of the National University of Ireland to M. J. Cranley for research in chemical physics at the Royal Institution, London. *India:* on the recommendation of the Indian Institute of Science, Bangalore, to G. N. I. Ramachandran for research in physics at the University of Cambridge; and K. R. Surange for research in plant morphology and palæobotany at the University of Cambridge or the University of Reading.

Rockefeller Travelling Fellowships in Medicine

THE Medical Research Council announces that it has awarded Rockefeller Medical Fellowships to the following, for the academic year 1946–47: Dr. Sheila T. E. Callender, graduate assistant, Nuffield Department of Clinical Medicine, Oxford; Dr. C. E. Dent, research assistant, Medical Unit, University College Hospital, London; Mr. A. M. Jones, Leverhulme Research Scholar (Royal College of Physicians), University and Royal Infirmary, Manchester; Dr. A. M. Macdonald, Department of Pathology, University of Edinburgh; Dr. J. E. Morison, lecturer in morbid anatomy, Queen's University, Belfast; Dr. F. T. C. Prunty, lecturer in chemical pathology, St. Thomas's Hospital Medical School, London; Dr. F. F. Rundle, surgical specialist, R.A.M.C., lately chief assistant and registrar, Westminster Hospital, London; Dr. J. Swinney, assistant surgeon, Department of Urological Surgery, Newcastle-on-Tyne General Hospital.

The Council has also awarded a Dorothy Temple Cross Research Fellowship in Tuberculosis to Dr. T. F. Jarman, assistant tuberculosis physician, Welsh National Memorial Association.

Poultry Mission to North America

THE Minister of Agriculture and Fisheries, in conjunction with the Secretary of State for Scotland, has arranged to send a mission to North America for the purpose of investigating, on behalf of the agricultural departments and their poultry advisory committees, the progress in the development of the poultry industry that has been made in the United States of America and Canada during recent years, and in particular to examine the stock improvement schemes in both countries. It is contemplated that the mission will start early in October and will spend a month in the United States, followed by a fortnight in Canada. It is proposed that the mission will consist of the following: Dr. R. Coles, superintending poultry advisory officer of the Ministry of Agriculture and Fisheries; Dr. A. W. Greenwood, acting director, Institute of Animal Genetics, University of Edinburgh; Mr. R. F. Gordon, senior research officer, Ministry of Agriculture and Fisheries, Veterinary Laboratory, Weybridge; Mr. C. Hedderwick, Somerset Poultry Farm, Bathpool, Taunton, Somerset; Mr. J. Sutton, The Clifton Pedigree Poultry Farm, Clifton, near Preston; Mr. G. Sykes, Queen Manor Farm, Laverstock, Salisbury.

International Hematology and *Rh* Conference

AN International Hematology and *Rh* Conference will be held in Dallas, Texas, on November 15. This conference will be held in affiliation with the Second Mexican Blood Transfusion Congress which meets in Mexico City during November 17–25. The guest speakers will include Dr. Philip Levine (New Jersey), Dr. R. R. Race (Lister Institute), Dr. William Dameshek (Massachusetts), Dr. Ernest Witebsky (New York), Dr. I. Davidsohn (Chicago), Dr. Louis K. Diamond (Massachusetts), Dr. Ludwig Hirszfeld (Wroclaw, Poland), Dr. I. G. Guzman (Mexico City), Dr. E. Uribe Guerola (Mexico City), and Dr. J. M. Hill (Texas). The secretary of the meeting is Dr. Sol Haberman, William Buchanan Blood, Plasma and Serum Center, Baylor University Hospital, Dallas, Texas.

Announcements

THE Eleventh International Congress of Pure and Applied Chemistry will meet in London, under the presidency of Lord Leverhulme, during July 16–24, 1947, concurrently with the celebration of the centenary of the foundation of the Chemical Society. Further information about the Congress can be obtained from the honorary organiser, Eleventh International Congress of Pure and Applied Chemistry, 56 Victoria Street, London, S.W.1.

THE British Mycological Society will hold its fiftieth anniversary meeting at the Royal Institution, London, during October 23–25. The programme is so organised as to correlate mycology with other subjects —mycorrhiza, soil fungi, seed-borne diseases, medical mycology, antibiotics, growth substances. It is hoped that overseas mycologists will be able to attend the meeting. Further information can be obtained from the Secretary, British Mycological Society, British Museum (Natural History), Cromwell Road, London, S.W.7.

A CONFERENCE of the Nutrition Society is being held on September 21, beginning at 10.30 a.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1. This precedes a general business meeting of the Society, which is to be held there on the same afternoon at 2.30 p.m. The programme and time-table are as follows: "The Work and Aims of the Food and Agriculture Organisation" (papers are to be read by Sir John Orr, Director-General of the Food and Agricultural Organisation); Mr. D. Lubbock ("Nutritional Aspects of the World Food Picture"); Dr. P. Lamartine Yates ("The Development of Food Supplies"); Dr. W. R. Aykroyd ("The Nutritional Programme of F.A.O."); Miss E. Fautz ("World Needs for Processed Milk"). Further details can be obtained from the hon. secretary, Dr. Leslie J. Harris, Nutritional Laboratory, Milton Road, Cambridge.

UNIVERSITY COLLEGE, Nottingham, has announced two new appointments in the Faculty of Agriculture and Horticulture. Mr. R. T. Pearl, head of the Department of Biological Sciences at Wye College (University of London) and editor of *Scientific Horticulture*, the journal of the Horticultural Education Association, has been appointed to the newly created post of director of horticultural studies and reader in horticulture. Mr. Pearl will be responsible for the development of teaching and research in horticulture and will take up his duties on January 1, 1947, at the Midland Agricultural College. Mr. R. F. Martyr has been appointed lecturer in fruit and vegetable culture at the Midland Agricultural College and will shortly take up his duties. Mr. Martyr has held senior posts in the Horticultural Advisory and Educational Service in the North Midland counties and is at present horticultural advisory officer to the County of Lindsey.

LETTERS TO THE EDITORS

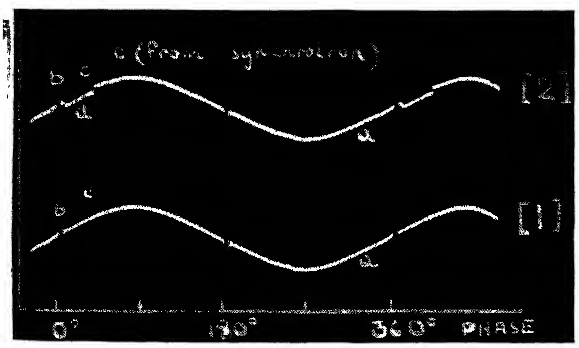
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Experimental 8 MeV. Synchrotron for Electron Acceleration

THE synchrotron principle has been suggested by Veksler[1] and McMillan[2] as a possible means of accelerating electrons to high energies. This letter describes modifications which have been made to a 4 MeV. betatron to convert it to an 8 MeV. synchrotron. The experiments prove that the synchrotron principle is a valid one for electron acceleration.

The betatron chosen for modification[3] was one of Kerst's early models, similar to that described by him[4]. It accelerates electrons to 4 MeV. when unmodified, and X-rays are produced by allowing the orbit to collapse so that the electron beam strikes a tungsten target. The equilibrium orbit is at 7·5 cm. radius and the target is at 4·6 cm. radius, so that there is a considerable delay between the time when the central core saturates and the emission of the X-rays. In operation as an unmodified betatron we have the following conditions: peak field at equilibrium orbit, 2,000 gauss; 50 cycle R.M.S. current in field coils, 35 amp.; central core saturates at a phase of 24° relative to the minimum field; electrons strike the target at a phase of 90°, that is, when the field is maximum. The current in the exciting coils was now stepped up to 70 amp., the maximum permissible without breakdown. This did not increase the energy of the electrons, since saturation of the core now occurred earlier and consequently the electrons struck the target well before the exciting field reached its maximum. The following conditions now pertained: peak field at orbit, 4,000 gauss; central core saturated at phase of 12°; electrons struck target at phase of 30°. To demonstrate synchrotron action it was only necessary to show that, with the betatron thus over-run, the electrons could be made to strike the target at a phase of 90° by suitable application of radio-frequency acceleration. Then it would follow that the energy had been doubled (to 8 MeV.).

To indicate this experimentally the following wave-forms were superposed on an oscilloscope: (*a*) the current in the field coils (which is proportional to the magnetic field), (*b*) the voltage applied to the injector gun, which was a very heavily damped oscillation produced by a peaking transformer, (*c*) the response from a Geiger-Muller counter placed in the X-ray beam, (*d*) the rectified envelope of the R.F. voltage across the resonator. The traces obtained with and without the R.F. voltage are shown in the photographs 1 and 2. The letters correspond to the wave forms listed above.



1, No R.F. (betatron); 2, with R.F. (synchrotron)

It will be seen that with the R.F. off there was only a single counter response at a phase of 30°. With the R.F. on, the expected counter response due to the synchrotron was obtained at 80° (showing 8 MeV.) as well as a response persisting at 30° showing that all the electrons were not caught. The synchrotron response could be moved about in phase by alteration of the R.F. pulse width, keeping its starting point constant.

The fact that a considerable proportion of the electrons were being accelerated to high energies was confirmed by placing an ionization chamber in the X-ray beam. The ionization produced was increased by a factor of 4 times on switching on the R.F. voltage. This is in agreement with an expected increase in conversion efficiency at the target for higher energies. If all the electrons could be accelerated to 8 MeV. the increase factor would probably be about six times[5].

The R.F. apparatus used was chosen for availability and ease of construction, and no attempt was made to remove many obvious deficiencies. The accelerating voltage was produced by a quarter-wave long resonator of the coaxial line type[6] excited at 640 Mc./s. by a small loop. The electrons passed up the hollow inner conductor of the resonator and were accelerated at the gap. The resonator could not be solid, or eddy currents would have disturbed the electron orbits. It was therefore constructed from 26 S.W.G. wires, 1/16 in. apart, mounted on distrene spacers. The wires were shorted together at the current antinode only. The whole was bent into a quadrant round the circumference of the 'doughnut' and was completely external to it. The R.F. field produced was markedly inhomogeneous, since only those wires which were of resonant length were strongly excited. In addition the field was reduced by the presence of the porcelain doughnut and its 'Aquadag' coating, and by the proximity of the magnet. These disadvantages were outweighed by the ease of construction of the resonator. The R.F. power was produced by a small C.W. oscillator, feeding a buffer amplifier which was modulated to give an R.F. pulse of variable length and phase, reaching its full value in 10 microsec. The mean power supplied was about one watt and the peak accelerating voltage across the resonator was appreciably less than 100 volts. It appeared that an increase in the power supplied would have increased the X-ray yield, as also would steepening the leading edge of the R.F. pulse.

The results we have so far obtained certainly indicate that the synchrotron is a powerful means of accelerating electrons, and show clearly its advantage over a betatron in giving much greater energy and X-ray yield without increase in magnet size.

This work was carried out as part of the programme of the Telecommunications Research Establishment of the Ministry of Supply. Acknowledgment is made to Mr. A. R. Greatbatch for facilities provided in his Department to use the betatron, and to the assistance given by our various colleagues at Telecommunications Research Establishment and the Armament Research Department. We also thank the Directorate of Atomic Energy for permission to publish these results.

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Aug. 20.

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Space-diversity Reception and Fading of Short-wave Signals

IT is well known[1,2] that fading patterns of short-wave signals as received on two or more aerials spaced a few wave-lengths apart are independent of each other; and this fact has been utilized in space-diversity reception, where the outputs from separate receivers connected to such aerials are mixed together in order to obtain a fairly constant signal level. It is generally assumed, however, that the variations of intensity of signal on a single aerial are of random nature caused by scattered waves from diffracting centres in the ionosphere[3,4].

As a preliminary to the investigation of the various modes of diversity reception within a limited space, we have recently made a large number of visual[5] and automatic ink records of fading of short-wave signals received from All India Radio, Delhi, situated at a distance of 678·4 km. It has been observed that there are occasions when the nature of fading of the signals rapidly changes from random variations of peaky type to a smooth and quasi-periodic nature, often accompanied by slow changes of a few minutes. Observations have been made on 41, 31, 25, 19 and 16-metre bands, with vertically polarized waves, mostly during the day-time. The slow variations associated with the quasi-periodic nature of the fading suggest that purely random variation, agreeing with Rayleigh intensity distribution, may occur so long as the wave suffers single-spot reflexion in the ionosphere; but, as soon as the signal undergoes two or more reflexions, either from one

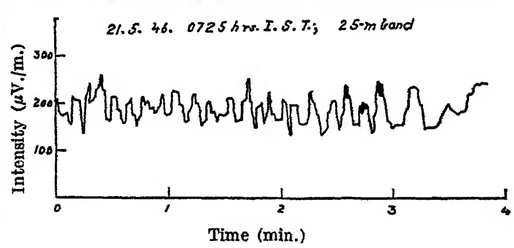

Fig. 1

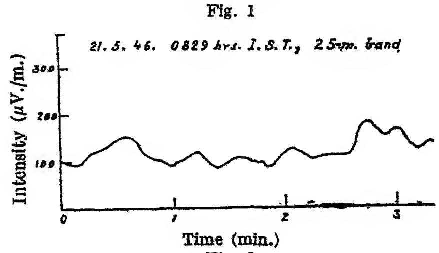

Fig. 2

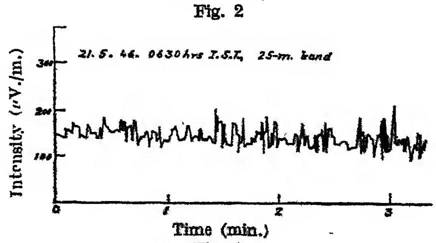

Fig. 3

ionospheric layer or from two different layers simultaneously, the fading pattern changes from random type to comparatively smooth and quasi-periodic type, with slow variations, resembling the pattern in the output of diversity receivers[6].

Automatic ink records of the fading pattern have been made with a 7-valve superheterodyne receiver after removing the incorporated automatic volume control system. The rectified signal from the second detector was amplified by a neon-coupled two-stage D.C. amplifier, the output of which was applied to the pen recorder with vertically moving paper, run by a self-governed electric motor. The speed of paper was maintained at 4·5 cm./min. Three typical records of fading of signals are reproduced. Fig. 1 shows the usual peaky and random variations on the 25-metre band in the morning hours due to single hop path necessitated by low ionic density. Towards the end of this diagram it will be seen that the variation tends to be less rapid, as just after that time the fading pattern changes gradually to the type shown in Fig. 2, which exhibits the delineation of the same signal received later, with quasi-periodic nature accompanied by slow variations caused by double reflexion at two different spots in the ionosphere. For the sake of comparison, a typical record of random fading of the B.B.C. (London) station is shown in Fig. 3, and it will be observed that the pattern of fading is similar to that in Fig. 1, as both the signals have presumably undergone single reflexion in the ionosphere. Thus the fading patterns shown in the above records indicate that the type of variation of intensity of signals changes as the number of reflecting spots in the ionosphere is altered.

Calculations made from the average equivalent heights of the *E* and *F* layers[7,8,9], and the required angle of radiation from Delhi station show that electronic concentrations of about $1·5 \times 10^5$ to $6·4 \times 10^5$ electrons per c.c. and $4·7 \times 10^5$ to $1·2 \times 10^6$ electrons per c.c. for single and double reflexions respectively would be necessary for an incoming wave of the 25-metre band. The hours of such concentration in the *E*-layer as observed at Calcutta[10] agree fairly well with the occurrence of the above change in fading pattern, especially during morning hours between 0630 and 0930 hours I.S.T., during which period the rise in ionic density is very rapid. Thus the above observations are useful in explaining the principle and application of diversity reception, and also in throwing light in the direction of further development of such systems.

A detailed account of the above investigations will be published elsewhere. We thank Principal M. Sengupta for his interest during the progress of the work.

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July 18.

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Production of High-Frequency Energy by an Ionized Gas

IT has been observed that the inner conductor of a coaxial line tuned to frequencies near 1,000 megacycles which projects into an arc discharge in mercury vapour can be excited by the discharge if a bar magnet is brought near the tube. Both a thermionic tube and a mercury pool tube showed this behaviour.

The inner conductor of a tunable concentric half-wave transmission line projected about 1 cm. into each discharge tube (4 cm. diameter, 70 cm. long) at a distance of 10 cm. from the anode. The line was coupled to a superheterodyne receiver tunable to frequencies near 1,000 megacycles, with a band-width of 4 megacycles.

When a bar magnet was brought near the tubes with its axis parallel to the tube axis, the discharge divided into two regions separated by a dark space. The region near the anode was pinkish in contrast to the region near the cathode.

When the boundary of the anode region was made to coincide with the extension of the inner conductor of the line, the receiver indicated an output corresponding approximately to 1 millivolt on the end of the line. This amplitude increased about three times as the temperature of the condensed mercury was reduced from 24° C. to 0° C. Noise of lower amplitude could also be detected for positions of the boundary between the line projection and the cathode. No input was observed in the cathode region or in the absence of the magnet.

With the thermionic cathode and a condensed mercury temperature of 11° C., Langmuir probe measurements indicated electron temperatures of approximately 30,000° K. and 26,000° K. for the cathode and anode regions respectively. The discharge current with the magnet present was about 0·35 ampere, and 1 ampere in its absence. When the discharge was in this condition the resistance in series with the tube could be heard 'singing'. A cathode ray tube connected directly across this resistance showed a trace of the form associated with low frequency noise having an amplitude up to 10 volts. In general, the noise levels observed with the cathode ray tube and with the superheterodyne receiver varied similarly.

The tube with an anchored spot cathode contained two anodes, that nearer the cathode drawing currents of the order 3 amperes, the other drawing smaller currents. Under these conditions a noise was observed which corresponded to 0·7 volt between the top anode and the cathode; on bringing a magnet near the tube this amplitude rose to 3 volts. A probe situated between the two anodes indicated electron temperatures of 15,500° K. and 19,000° K. in the cathode and anode regions respectively. The discharge current with the magnet present was about 0·79 ampere, and 0·92 ampere in its absence.

A similar increase in noise at frequencies up to 5 megacycles on the application of a magnetic field has been reported by J. D. Cobine and by C. J. Gallagher in 1944.

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Momentum Spectrum of Mesons at Sea-Level

A SERIES of cloud-chamber measurements of the momentum spectrum of mesons at sea-level has been made, extending the spectrum to the important low-momentum region which is modified by meson decay. A short reference to this work, which was completed in the summer of 1939, was given by Rossi[1].

Measurements of the meson spectrum at low momenta are complicated by the presence of a considerable electron component, and by instrumental selection arising from the strong curvature of the tracks and from large scattering. In order that mesons might be identified with certainty, the low momentum spectrum, $p < 10^9$ *ev./c.*, was obtained from tracks traversing 2 cm. of gold, and for these measurements the corrections for scattering of the particles in the gold plate were large. A check was made, by a series of photographs taken with a weak magnetic field and with the lower selecting counter in the middle of the chamber, immediately below the metal plate in which the greater part of the scattering took place, that this spectrum was truly normalized to the main high momentum spectrum. These checking measurements were relatively inaccurate, but in them the ratio of the number of low momentum particles to the number of high momentum particles was not subject to large instrumental bias.

The high momentum spectrum to which the lower range was normalized is given in Table 1, together with the more extensive results of Blackett[2] and Jones[3]. In the highest ranges, $p > 10^{10}$ *ev./c.*, the large number of particles reported by Jones is not confirmed. This group may well be over-emphasized in Jones's spectrum as a result of the non-Gaussian form of the distribution of instrumental errors to which he directs attention.

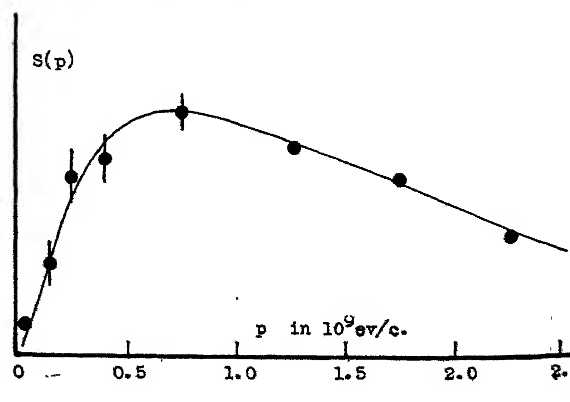
TABLE 1. THE MESON SPECTRUM, $p > 10^9$ *ev./c.*

	Blackett	Jones	Wilson
Total number of particles, $p > 10^9$ *ev./c.*	620	802	301
Range of momenta (*ev./c.*)	Number of particles for a total of 1,000 in the range 10^9–10^{10} *ev./c.*		
10^9–$2·10^9$	383	393	367
$2·10^9$–$3·10^9$	219	243	223
$3·10^9$–$6·10^9$	280	258	288
$6·10^9$– 10^{10}	118	106	122
10^{10}–$2·10^{10}$	86	(289)	102
$2·10^{10}$ upwards	80		82

TABLE 2. THE MESON SPECTRUM, $p < 10^9$ *ev./c.*

Range of momenta (*ev./c.*)	Number of particles for a total of 1,000 in the range 10^9–10^{10} *ev./c.*
$5·10^8$– 10^9	238 ± 18
$3·10^8$–$5·10^8$	76 ± 9
$2·10^8$–$3·10^8$	35 ± 6
10^8–$2·10^8$	18 ± 4
$3·10^7$ (Williams)	2 in a band of about $3·10^7$ *ev./c.*

The low momentum spectrum (Table 2) is based on 123 tracks with $p < 10^9$ *ev./c.*, and the values are given in the table in a form directly comparable with those of Table 1. In the diagram, the differential momentum spectrum is given up to a momentum rather greater than $2·10^9$ *ev./c.*, the probable error of points based on the new low momentum spectrum being indicated.



At very low momenta, $p < 10^8$ *ev./c.*, mesons are distinguished from electrons by heavy ionization in the cloud chamber rather than by behaviour traversing a metal plate. The technique of random expansions in a large chamber with a low magnetic field, adopted by Williams[4], is of particular value in this region, and a measurement by Williams is included in the table and in the diagram.

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Aug. 16.

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Viscosity of Associated Liquids

EXISTING theories of the viscosity of liquids fail to give a satisfactory account of the temperature variation of the viscosity of certain associated liquids. The X-ray diffraction patterns of liquids show that the inter-atomic distances vary about a mean; the variability increasing with increasing temperature. In addition, for the silicate glasses and for water, it is concluded that the structure is a random three-dimensional network of atomic bonds. This network is continuous throughout the liquid and in this sense glasses and water are associated liquids. In glasses the network is built up of Si—O bonds and in water of O—H bonds, the silicon atoms being surrounded by four oxygen atoms, and in water, the oxygen atoms by four hydrogen atoms.

Owing to the variability of the inter-atomic distances, some of the Si—O—Si or O—H—O links are so long that the position of equilibrium of the central atom ceases to be midway between the two outer atoms. Two positions of equilibrium for the central atom now appear, one to each side of the midpoint, with a potential barrier between them. When a shear force is applied the barriers will be lowered in the direction of the force, and there will be a drift of atoms in that direction. If it be assumed: (1) that thermal motion ensures that, at constant temperature, the number of atoms having such alternative positions available to them remains constant, and (2) that the four co-ordinated atoms have always only one position of minimum potential energy available which moves with the flow; then an expression can be set up for the viscosity of the liquid.

As the variability of the inter-atomic distances increases the number of atoms having alternative positions available to them will increase. To obtain a simple expression for the viscosity as a function of temperature the assumption may now be made that the two-bonded atoms fall into two classes, (*a*) no alternative position available, (*b*) two equilibrium positions available separated by a potential barrier of height E at a distance apart a; E and a are taken to have the same values for all atoms in class (*b*). The expression for the coefficient of viscosity then becomes

$$\eta = \frac{1}{\omega} QT\, e^{E/kT}, \quad . \quad . \quad . \quad (1)$$

where η is coefficient of viscosity, T is absolute temperature, ω is fraction of total number of two bonded atoms in class (*b*), Q is a constant and k is Boltzmann's constant.

Having made the assumptions of the previous paragraph it appears that the variation of the number of atoms in class (*b*) with temperature might be found by a process similar to that used in the cases of Frenkel and Schottky defects in ionic lattices. An expression for the variation of ω with temperature found in this way and substituted in (1) gives

$$\eta = T\,(Ae^{B/T} + Ce^{D/T}), \quad . \quad . \quad (2)$$

where A, B, C, D are constants which in a more accurate expression would be slowly varying functions of temperature (that is, of the order of volume changes with temperature).

This equation has been fitted to the experimental results for a lime-soda-silica glass and for water. Comparison is made between the calculated and experimental values in the table.

Lime soda glass

Equation found

$$\eta = T\,(2{\cdot}86 \times 10^{-19}\, e^{30,980/T} + 2{\cdot}11 \times 10^{-9}\, e^{27,620/T})$$

Temperature ° C.	1127	1027	827	627
$\log_{10} \eta$ Exp.	3·06	3·620	5·37	9·05
Calc.	3·154	3·680	5·366	9·048

Water

Equation found

$$\eta = T\,(3{\cdot}1 \times 10^{-11}\, e^{3,763/T} + 8{\cdot}78 \times 10^{-8}\, e^{1,620/T})$$

Temperature ° C.	100	80	60	40	20	0
η Exp.[1]	0·2838	0·3565	0·4688	0·6560	1·0050	1·7921
Calc.	0·2838	0·3569	0·4692	0·6570	1·0047	1·7460

Equation (2) may also be written

$$\eta = T A^1 e^{B^1/kT}\,[1 + C^1 e^{D^1/kT}]. \quad . \quad (4)$$

Here the expression in the square bracket gives the value of $\frac{1}{\omega}$ and the remaining terms are concerned with the flow.

In the case of water the equation becomes

$$\eta = T.e^{2\cdot 24 \times 10^{-13}/kT}.\, 8{\cdot}78 \times 10^{-8}\, [1 + 3{\cdot}54 \times 10^{-4}\, e^{2\cdot 94 \times 10^{-13}/kT}]. \quad (5)$$

Ubbelohde and Woodward[2] estimate the height of the potential barrier separating the two equilibrium positions of a hydrogen atom between two oxygen atoms 2·8 A. apart as $2{\cdot}2 \times 10^{-13}$ erg. and $1{\cdot}33 \times 10^{-13}$ erg. when the oxygen atoms are 2·75 A. apart. This compares favourably with $2{\cdot}24 \times 10^{-13}$ obtained from equation (5).

For the case of Schottky defects in rock-salt Mott and Gurney[3] estimate $C^1 \sim 10^{-3}$–10^{-4} and $D^1 \sim 30 \times 10^{-13}$; the values obtained thus appear to be reasonable.

The constant A^1 corresponds with Q in the equation (1) and the theoretical value agrees with the value from the viscosity data to within a factor of 10. Bearing in mind the nature of the approximations made, the rough numerical agreement of the constants in the equation fitted to the viscosity data with their estimates by other means is at least suggestive that the theory is on correct lines.

A full account of this work is being prepared for publication.

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Aug. 22.

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Mechanism of Creep in Metals

IT is thought that the experimental observation described in the present note leads to new and useful information on the mechanism of creep in metals, a problem which was the subject of a recent conference at the Royal Society[1].

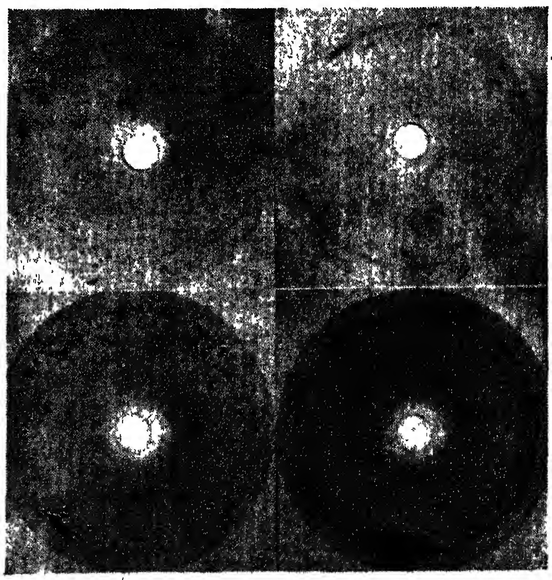
The observation will be better appreciated if reference may first be made to the following relevant results from previous work at the National Physical Laboratory on the structural changes revealed by X-ray diffraction when a metal is plastically deformed.

(*a*) Under normal static loading of a *polycrystalline* metal, the grains break down into crystallites characterized by widely differing orientations, and for a given metal, a particular lower limiting size. This has been termed the random crystallite formation[2].

(*b*) Under similar loading of a *single metal crystal*, a dislocation of the mosaic structure occurs, but the mosaic elements in general remain approximately parallel. This condition has been termed the 'parallel crystallite formation', to distinguish it from the case of the polycrystalline metal, and to emphasize the point, not generally realized, that the behaviour of the isolated single crystal in this respect is quite different from that of the metal crystal in the aggregate[3].

It was considered that a difference in this fundamental process of breakdown of the grains might be a factor distinguishing the normal short-time deformation of a polycrystalline metal in a tensile test with increasing stress from continuous deformation at the much slower rate known as 'creep'. This has proved to be the case. A specimen of aluminium, initially annealed, was stretched at 300° C. in a normal tensile test to an extension of 0·9 per cent, the extension being completed in about two minutes; it was then unloaded, cooled and examined by X-rays. A similar specimen was allowed to creep under a load of ½ ton/sq. in. at the same temperature until the same extension was reached, but the extension took fifty minutes. X-ray examination then showed that the tensile specimen showed the random crystallite formation referred to in (*a*) above, but the creep specimen had the

1 2



3 4

parallel crystallite formation referred to in (*b*). Thus, in creep, the polycrystalline specimen had deformed like a single crystal.

It should be added that when the tensile specimen after unloading was held at the elevated temperature for the same time as the creep specimen, no appreciable recovery in structure occurred.

The effect is illustrated in Figs. 1, 2, 3 and 4. Fig. 1 is a back-reflexion photograph from the metal in the initial state; the sharp (420) reflexion spots indicate perfect strain-free grains. Fig. 2 is from the tensile specimen after extension; the transition from reflexion spots to an almost continuous ring indicates the extensive nature of the breakdown to the random crystallite formation even after only 0·9 per cent extension. Fig. 3 is from the creep specimen, and shows that the reflexions are still relatively sharp spots, indicating a minimum disturbance of the internal structure of the grains. Fig. 4 is from the extended tensile specimen after it had been heated at 300° for 1 hour, and shows that no appreciable recovery or recrystallization has taken place.

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National Physical Laboratory,
Teddington. Aug. 12.

[1] Allen, N. P., *Nature*, **157**, 469 (1946).
[2] Wood, W. A., *Proc. Roy. Soc.*, A, **172**, 231 (1939).
[3] Wood, W. A., *Proc. Phys. Soc.*, **52**, 110 (1940).

Standard Entropy of Adsorption

WE have recently shown[1], by a thermodynamical procedure, how the standard free energy of adsorption of a solute on to a solution/air interface (ΔG°) may be obtained from the limiting slope α at low concentrations of the surface tension-concentration curve. This is given by the equation

$$\alpha = \delta RT \exp.(-\Delta G^\circ/RT) \quad . \quad . \quad (1)$$

where α is $-(d\gamma/dc)_{c=0}$ and δ is the thickness of the surface layer, which was identified with the most probable length of the adsorbed molecule. The standard states in bulk and on the surface are hypothetical states in which the solute is at unit activity in each (activity is expressed in molality units), but essentially have all the properties of infinitely dilute solutions.

It is possible to obtain the standard entropy of adsorption (ΔS°) from this. Differentiation of equation (1) with respect to T gives

$$\Delta S^\circ = -\left(\frac{\partial \Delta G^\circ}{\partial T}\right)_P = -\frac{\Delta G^\circ}{T} + \frac{RT}{\alpha}\frac{d\alpha}{dT} - R \quad . \quad (2)$$

In the derivation of equation (2), the entirely justifiable assumption is made that δ does not vary appreciably with temperature within any reasonable range of temperature. Unfortunately, little experimental work has been carried out on the variation of α with temperature. The only available data are from measurements by Rehbinder[2] of the surface tensions of solutions of fatty acids of various chain-lengths at different temperatures and concentrations. The accuracy of these determinations is not high, but they allow a systematic series of values of $d\alpha/dT$ to be calculated. If these values are used in conjunction with the more accurate values of α at 20° C. recently given by one of us (A. F. H. W.)[3], it is possible to arrive at a numerical estimate of ΔS° for the adsorption of some members of the fatty acid series at an aqueous surface. These values of ΔS° calculated by means of equations (1) and (2) are shown in the accompanying table.

Solute	ΔG° kcal./mole	ΔS° cal./° C. mole	ΔH° kcal./mole
Propionic acid	−1·63	−14·4	−5·9
n-Butyric acid	−2·45	− 6·2	−4·3
n-Valeric acid	−3·18	+ 1·1	−1·8
n-Caproic acid	−3·72	+ 6·6	−1·7
n-Heptoic acid	−4·52	+ 7·2	−2·4

The data for *n*-caproic and *n*-heptoic acids are likely to be less accurate, since with chains of this length the time-dependence of surface tension becomes important and Rehbinder's method[2] was not suitable to take account of this. The apparent falling off in the ΔH° values for these two compounds may be illusory, and more account should be taken of the increasing trend shown by the lower members of the series.

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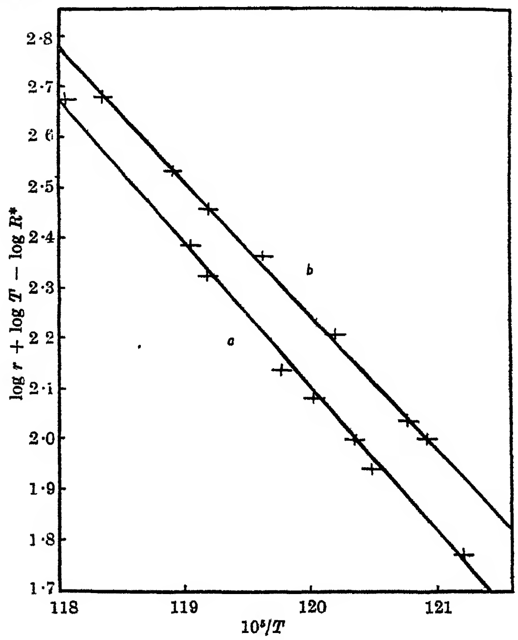
July 28.

[1] Ward and Tordai, *Trans. Farad. Soc.*, **42**, 413 (1946).
[2] Rehbinder, *Z. Phys.*, **52**, 641 (1924).
[3] Ward, *Trans. Farad. Soc.*, **42**, 399 (1946).

Chain-initiating Process in the Reaction between Hydrogen and Oxygen between the Second and Third Explosion Limits

THERE has been much discussion concerning the reaction responsible for the initiation of chains, in the thermal reaction between hydrogen and oxygen, in the non-explosive region between the second and third explosion limits[1]. In their early work[2], Lewis and von Elbe favoured the thermal dissociation of hydrogen, but in a later paper[3] they reject this view because their value of the overall activation energy is "of the order of only 100 K-cals" which they regard as the sum of the activation energies of the chain-initiating and chain-propagating steps, and hence conclude that the energy of activation of the initiating reaction is less than 100 kcal. This value excludes the dissociation of hydrogen (and, of course, oxygen, but the thermal dissociation of this molecule is not considered for valid kinetical reasons) as the chain-initiating reaction, and to meet these conditions, these authors postulate the dissociation of hydrogen peroxide according to $H_2O_2 \rightarrow H_2O + O$ or $2OH$, without being very precise about the origin of the hydrogen peroxide, other than assuming that the reaction $H_2 + O_2 \rightarrow H_2O_2$ may play a part initially. Recently, Willbourn and Hinshelwood[4] have made a fresh experimental study of the third limit and the slow reaction at lower pressures and, in contrast to Lewis and von Elbe, conclude that the initiation reaction is probably $H_2 + M \rightarrow 2H + M$.

A choice between these two mechanisms is possible if the energy of activation of the initiation process is carefully determined. Accordingly, we have obtained pressure-time records at many temperatures within the range 555°–575° C. at pressures equivalent to: (*a*) 200 mm. H_2 + 110 mm. O_2 at 577° C. and (*b*) 300 mm. H_2 + 150 mm. O_2 at 577° C., under conditions approximating as closely as possible to those of Willbourn and Hinshelwood. A cylindrical silica vessel coated internally with potassium chloride and held in a thermostatically controlled horizontal electric furnace was used as reaction vessel and a mirror type Foord gauge used as a manometer. The rest of the apparatus was of conventional design. The reproducibility of the results was good.



Under steady state conditions when the chains are terminated linearly, the rate of a chain reaction is the rate of initial production of centres divided by the net branching factor and multiplied by the reciprocal of the mean life of the centres[5]. The denominator in the expression can be evaluated in terms of the experimental variables from studies of the adjacent explosion boundary, at all points on which, provided thermal influences are absent in the explosion, the denominator is zero[5]. Using such reasoning, Willbourn and Hinshelwood write r (the rate of pressure change in mm. Hg min.$^{-1}$) $= f_1R^*/$ (constant) T, where f_1 is the rate of the initiating reaction, the contant is independent of temperature, and R^* is a function of temperature and concentration of reactants which can be calculated from the experimental data on the third limit. The energy of activation of the initiation reaction can then be obtained from the slope of the curve obtained by plotting ($\log r + \log T - \log R^*$) against T^{-1}. The figure shows the results obtained in our experiments. They are linear in confirmation of the general validity of Willbourn and Hinshelwood's mechanism; and lead to values of the activation energy for the initiation reaction of 134 ± 4 and 123 ± 3 kcal. for (*a*) and (*b*) respectively; thus virtually excluding the initiation reaction proposed by Lewis and von Elbe and affording additional evidence for the thermal dissociation of hydrogen as this process.

Since M in this reaction includes oxygen molecules, a corollary to this conclusion is that a collision between highly energized hydrogen and oxygen molecules can, and often does, result in dissociation of the hydrogen rather than in reactions of the type: $H_2 + O_2 \rightarrow H_2O_2$ + 35 kcal., or $H_2 + O_2 \rightarrow 2HO$ − 20 kcal. (the heats given apply to molecules in their ground states)[6]. This result would not have been anticipated and is rather surprising on theoretical grounds.

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Laboratory of Physical Chemistry,
Cambridge. Aug. 16.

[1] The explosion limits are here numbered in order of increasing pressure. See also refs. 3 and 4 where the same convention is used.

[2] Lewis and von Elbe, "Combustion, Flames and Explosions of Gases", 39 (Cambridge, 1938).
[3] Lewis and von Elbe, *J. Chem. Phys.*, **10**, 376 (1942).
[4] Willbourn and Hinshelwood, *Proc. Roy. Soc.*, A, **185**, 353 (1946).
[5] For elaboration of this, see Dainton, *Trans. Farad. Soc.*, **38**, 227 (1942).
[6] Assuming the value of Q_s for H_2O_2 of 255·7 kcal. mole^{-1} given by Skinner, *Trans. Farad. Soc.*, **41**, 645 (1945), and Dwyer and Oldenberg's value of 100 kcal. for the bond energy in the OH radical (*J. Chem. Phys.*, **12**, 351 (1944)).

Production of Metabolic Benzpyrene Derivatives *in vitro*

It has been shown by Weigert and Mottram[1] that, independent of its mode of introduction into an animal, benzpyrene passes through a series of chemical changes prior to its final excretion. The following evidence suggests that the first derivatives—provisionally termed X_1 and X_2—are produced locally in those organs (liver, kidney, lung) where the benzpyrene is concentrated after intravenous or intraperitoneal injection, and also in the blood. The same happens in the subcutaneous tissues and in the skin of mice after the injection or painting of benzpyrene.

A series of mice were decapitated immediately after the intravenous injection of a colloidal suspension of benzpyrene. The shed blood and the carcasses were then stored at 0° C. and examined at intervals of a few hours for metabolic products. The amount of X_1 present in the liver, lung, kidney and the clotted blood increased slowly. Further, human blood was mixed with a benzpyrene suspension and the presence of X_1 was detected after a few hours by a sensitive fluorescence method.

The following technique has been adopted for the study of benzpyrene metabolism *in vitro*. Mice are clipped, killed and the whole of the skin between the fore and hindquarters is removed and placed on filter paper moistened with Ringer-Locke solution. Measured areas are painted with solutions of benzpyrene in acetone and then excised and floated on to Ringer-Locke solution in Petri dishes, the hair surface being uppermost. These are placed in the incubator at 37° C.

After incubation for periods of three hours or more the presence of X_2 can be shown. On the basis of its absorption and fluorescence spectra and its behaviour towards various solvents, the X_2 formed under these conditions would appear to be identical with that formed in the mouse skin after painting the living animal and after intravenous or intraperitoneal injection. Quantitative estimations (full details of the methods used will be published elsewhere) indicate that when a dilute solution of the benzpyrene (0·002 per cent in acetone) is applied, up to 40 per cent is recoverable in the form of X_2.

The use of this *in vitro* technique with the mouse skin shows definitely that the first stage of the metabolic conversion is the same as *in vivo* and takes place at the site of application of the benzpyrene.

Records of detailed studies using this *in vitro* system and the corresponding *in vivo* system are now in course of preparation for publication.

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[1] Weigert, F., and Mottram, J. C., *Cancer Res.*, **6**, 97 (1946).

Relation of Crystal Size and Shape to Contact Toxicity of D.D.T. Suspensions

It is frequently found that in two-phase disperse insecticidal systems in which the toxic compound constitutes part or whole of the disperse phase, toxicity bears an inverse relation to the particle size of the disperse phase. Recent work here has shown, however, that in the case of aqueous suspensions of pure *p,p'*-D.D.T. [1-trichloro 2,2-bis(*p*-chlorophenyl) ethane], this relationship is reversed.

p,p'-D.D.T. normally crystallizes in needles[1], but in certain circumstances can be made to form plate-like crystals. In the preparation of suspensions the overall size as well as shape of crystal can be varied. This does not involve any changes in the fundamental habit of the crystal, but merely variations in the external form produced by different growth conditions. In this way, suspensions of six distinct types, each of characteristic and fairly uniform crystal size and shape, have been prepared and tested here against *Tribolium castaneum* Hb. (red-rust flour beetle), using, chiefly, a recently developed dipping technique[2]. Within the range of crystal sizes tested, namely, from colloidal D.D.T. to a suspension of needle-shaped aggregates 350 μ long, toxicity is associated primarily with overall length, and increases with length; breadth is of lesser importance, but it seems definite that increasing the breadth of a crystal from a needle to a plate shape subtracts somewhat from its toxicity. Thus, of all the sizes tested, colloidal D.D.T. is least, and 350 μ needles most, toxic. The ratio of the median lethal doses of these extreme sizes is of the order of 12 : 1.

There must, of course, be an upper limit to the toxicity, for it is obvious that an increase in the crystal dimensions beyond certain limits would not be accompanied by a corresponding increase in toxicity. As the choice of 350 μ needles as a standard size was purely one of convenience, it is scarcely likely that such a suspension does represent maximum toxicity.

These results are in line with those of Parkin and Green[3], who showed that the toxicity to houseflies of residual D.D.T. films increases with the age of the film and that this is related to slow crystallization of D.D.T. from a "poorly toxic gum-like residue".

The origin of these differences is not clear, but they are certainly not due to the few small differences in the media of the separate types of suspension. That they do not have their origin in any operation peculiar to the dipping technique is shown by the fact that similar differences are obtained with the Potter spraying apparatus[4]. However, it may be that with smaller particles there is a greater 'run off' of insecticide from the insects' bodies, that is, larger particles are retained more readily by irregularities on the cuticle surface. This would be equivalent, in fact, to a higher dosage; hence the higher kill.

Further work on this subject is in progress here and complete details will be published elsewhere at a later date.

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Department of Insecticides and Fungicides,
Rothamsted Experimental Station,
Harpenden, Herts. Aug. 14.

[1] Gooden, E. L., *J. Amer. Chem. Soc.*, **67**, 1616 (1945).
[2] McIntosh, A. H., in the press.
[3] Parkin, E. A., and Green, A. A., *Nature*, **155**, 668 (1945).
[4] Potter, C., *Ann. Appl. Biol.*, **28**, 142 (1941).

An Insect Vector of the Turnip Yellow Mosaic Virus

In a recent communication[1] we described a new virus attacking turnips, which we had isolated in crystalline form. At that time we had found no insect vector for the virus, all the experiments with aphides having proved negative. However, since the virus attacks an annual crop like the turnip it seemed highly probable that some insect vector was involved, so further investigations were undertaken. A small plot of turnips was sown out-of-doors and a few infected plants placed at random in the plot. It was soon evident from the rate and manner of spread of the virus that some insect was transmitting it.

Examination of the insect fauna of the plot showed the only insects present in any number to be aphides and flea-beetles (*Phyllotreta* spp.). Since the aphides had already been tested with negative results attention was directed to the flea-beetles and the following experiment was carried out. Two insect-proof cubicles in the glasshouse were filled with healthy young turnip and Chinese cabbage plants and two infected plants were placed in each cubicle as a source of virus. In one cubicle a large number of flea-beetles, mostly *Phyllotreta cruciferæ* and *P. vittula*, were liberated; the other cubicle which acted as a control was kept free of insects. Ten days after the introduction of the flea-beetles into the cubicle, the first plant became infected; the following day three more plants developed the disease and during the next two days, five more. In the control cubicle there was no spread of the virus.

This seems fairly conclusive that the flea-beetle is, in fact, the vector of the turnip yellow mosaic virus, and if confirmed will be the first instance of virus transmission by a biting insect in Great Britain. Whether the transmission is a purely mechanical process is not yet certain, though it seems probable that this is so.

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Aug. 22.

[1] *Nature*, **157**, 300 (1946).

Carrot Fly Control

The control of carrot fly by the application of insecticides direct to the plant rows has shown interesting anomalies when compared with that of root flies of somewhat similar habits. Calomel, for example, effective against cabbage root fly, does not appear to work against carrot fly.

It is of interest to record in this connexion the results of trials made in 1945 comparing the efficacy of a D.D.T. (Geigy) 5 per cent dust and a benzene hexachloride dust containing 0·25 per cent gamma isomer as crude benzene hexachloride (formulated as *P.P.* flea-beetle dust). It is seen from the accompanying table that the control given by the benzene hexachloride (B.H.C.) is of a quite remarkable order, whereas only moderate control was effected by D.D.T.

Carrot Fly Trials 1945. Summary of replicates

	Total number of carrots examined	% Clean	% Slight attack	% Moderate attack	% Unsaleable
Control	236	12·7	18·7	11·9	56·7
D.D.T.	419	44·2	21	9·3	25·5
B.H.C.	350	99·7	0·3	—	—

Results obtained this year have, so far, been confirmatory.

The reason for this difference is not yet apparent. The characteristic odour of B.H.C. might suggest that a deterrent effect is involved, but this is scarcely borne out by the way protection so exactly followed the limits of distribution of the dust; in addition, a fumigant effect may not be out of the question. It is hoped to get further evidence on these matters.

One other point regarding phytocidal action may be mentioned. Unnecessarily heavy dressings of B.H.C. do not appear to have a hurtful action on the carrot, whereas with the Brassicæ even moderate dressings may seriously affect the stem at the point where contact is made—possibly a point of interest in regard to the mode of action of benzene hexachloride.

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Powdery Mildew of Potato

Powdery mildew on potato was first recorded in Great Britain in 1932, when the oidial stage was found on the leaves of seedling potatoes in a glasshouse at Cambridge[1]. It was again observed at Cambridge in the late summer of 1945, and a field survey was made to determine its prevalence. The mildew was found not only on seedling plants in the greenhouse, but also on potatoes in trial plots in the open. A search was then made for it in the immediate neighbourhood, and later this was extended to cover an area within a ten-mile radius of Cambridge.

Mildew was prevalent throughout the area inspected. Crops in the vicinity of the trial plots were most heavily infected, but elsewhere infection was greatest in the south-west of Cambridgeshire. Mildewed plants were found twelve miles away, namely, at Burwell, where a mild attack had developed in a garden.

In the field the disease was observed on the following varieties: Majestic, Dunbar Rover, Abundance, Dunbar Standard, Arran Victory and President. A number of hybrids, derived from parental stock of King Edward, were also affected. Majestic was the variety most noticeably attacked, but mildew was not observed on Kerr's Pink, Gladstone and Red Skin, or on any other Solanaceous plant.

Inoculation experiments were made on plants related to the potato, and on species known to be susceptible to *Erysiphe cichoracearum*.

The only plant successively inoculated was *Nicotiana tabacum* var. White Burley.

The mycelium was present on both surfaces of the leaves, but it was usually more abundant on one side than the other. In the greenhouse and trial plots near by, the upper surface was most commonly infected, while in the field the mycelium was more prevalent on the lower surface. Round to oval patches, about 1–3 cm. in diameter, were formed, and on severely infected leaves these coalesced. The affected areas were at first pale green, but afterwards developed a powdery-white appearance. In no case were the petioles or stems attacked, as described by Kunkel[2].

The haustoria, which were formed in the epidermal cells, were subglobose to ovate in shape, measuring approximately 41·5 μ by 27·5 μ. The mean dimensions of the conidia were 29·6 μ by 16·8 μ. No perithecia were observed. Ducomet, in France, observed that perithecia were formed on infected leaves, but the asci did not mature and he was unable to ascertain the species[3].

It is generally accepted that this mildew belongs to *Erysiphe cichoracearum*, though it has not been proved. This species, however, was definitely recorded on potato plants in France in 1927. No other reports of a powdery mildew on potato plants have been recorded in Great Britain other than from Cambridge.

I wish to acknowledge my indebtedness to Dr. W. A. R. Dillon Weston, who brought this disease to my notice, and for much helpful advice and criticism.

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[1] Pethybridge, G. H., *et al.*, Min. Agric. Bull. No. **79**, 31 (1934).
[2] Kunkel, L. O., *Phytopath.*, **26**. 4, 392 (1936).
[3] Ducomet, V., *Bull. Soc. Path. Veg.*, France, **8**, 153 (1921); cited in *Rev. Appl. Mycol.*, **1**, 361 (1922).

Transmission of *L. carinii* to Laboratory Animals

Dr. F. Hawking and Miss A. M. Burroughs in a letter to *Nature*[1] state that they have confirmed the reports of the American workers, Williams and Brown[2], and Scott (private communication), regarding the transmission of *L. carinii* to laboratory (piebald) rats, and that in addition they transferred the infection to hamsters and white mice.

The establishment of a strain of filariasis in such a universally available laboratory animal as the white rat would be of great value to workers in tropical medicine, since it would provide them with the means of studying the effects of drugs on a disease heretofore regarded as incurable, and this problem has recently been studied by us at the Liverpool School of Tropical Medicine. The results of our investigations, which will be published in the next number of the *Annals of Tropical Medicine and Parasitology*, although confirming the American workers' statement that *L. carinii* can be transmitted to white rats, do not support the view that a strain of *L. carinii*, suitable for chemotherapeutic investigation, can be successfully maintained in these animals.

Our preliminary observations agreed with those of Dr. Hawking in confirming the American work, but on more intensive study, we observed that although transmission of *L. carinii* from the cotton rat to the white rat could be successfully performed by means of the vector, *L. bacoti*, and although the infective forms reached the adult stage, became sexually mature, and produced microfilariæ, the adult worms in the pleural cavity of the white rat were progressively encapsulated and died within as short a period as 82 days of the first exposure to infection. This premature death of the adult worms has never been observed by us in the natural host, the cotton rat.

In further experiments in which adult *L. carinii* were transferred by surgical means from the pleural cavities of cotton rats to those of white rats, microfilariæ appeared in the peripheral blood of the latter some ten days afterwards, and persisted for a further three weeks, at the end of which period the animals were killed, and it was found that the parent worms were dead and in various stages of encapsulation.

We have not attempted to infect white mice or hamsters, but the results of the experiments reported by Dr. Hawking and Miss Burroughs suggest that these animals may react in a similar manner to white rats, and that caution must be exercised before accepting the view that the presence of microfilariæ in the peripheral blood of these animals necessarily implies that they are suitable hosts in which to establish a permanent strain of filariasis for chemotherapeutic studies.

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[1] *Nature*, **158**, 98 (1946).
[2] Williams, R. W., and Brown, H. W., *Science*, **102**, 482 (1945); **103**, 224 (1946).

Polyploidy in Sainfoin

AMONG the herbage crops, cocksfoot (*Dactylis glomerata* L.)[1] and bird's foot trefoil (*Lotus corniculatus* L.)[2] have been shown to be autotetraploids, and lucerne (*Medicago sativa* L.), having also given segregation ratios which can best be interpreted as tetrasomic, may be regarded as an autotetraploid[3]. Sainfoin (*Onobrychis viciæfolia* Scop.) is a tetraploid species with $2n = 28$ chromosomes compared with $2n = 14$ in *O. Caputgalli* Lam.[4]. The question arises whether it is an allo- or an auto-tetraploid. This can best be settled by genetical tests based on the difference between tetrasomic and disomic ratios, but the following observations seem sufficiently indicative to be worth reporting.

By colchicine treatment of seeds or seedlings, sainfoin plants have been obtained with double the normal number of chromosomes. They may be recognized by their pollen grains having nearly double the volume of those of normal plants. Abortion of seeds is characteristic of these plants, but occasional seeds have been obtained after open pollination in the presence of normal plants. These seeds give rise to 'triploid' progeny with 42 chromosomes. Other progeny with about 42 chromosomes have been raised from embryos dissected out of immature seeds and grown on nutrient agar until they form plants large enough to transplant to soil. 'Triploids' have a higher seed fertility than their maternal parent and have a surprisingly regular pollen, with between 0·1 and 5·4 per cent of unfilled grains as judged after acetocarmine staining. The relative volumes of the regularly formed grains of normal, 'triploid' and doubled plants are in the ratio 100 : 133 ; 182.

The first metaphase of meiosis in the pollen mother cells of a plant with 40 chromosomes (obtained by culture of an embryo produced by open pollination of a doubled plant) was studied in a preparation made by a modification of Thomas's method[5]. The following configurations were seen in five cells which could be analysed completely: 1 trivalent, 18 bivalents and 1 univalent (in each of two cells); 4 trivalents and 14 bivalents; 3 trivalents, 15 bivalents and 1 univalent; 19 bivalents and 2 univalents. These associations show that normal sainfoin is either an autotetraploid or an allotetraploid of the *Primula kewensis* type, derived by chromosome doubling of a hybrid with a high degree of chromosome pairing. It is not an allotetraploid of the *Raphanobrassica* type, derived by chromosome doubling of a hybrid with little or no pairing.

Confirmatory evidence was obtained from an examination of meiosis in normal sainfoin, which was found to have a low chiasma frequency (about 14 per cell), forming mainly bivalents with a single chiasma, occasional bivalents with two chiasmata, chains of four chromosomes and univalents. The low chiasma frequency is probably an adaptive mechanism which assists regular disjunction by reducing the frequency of higher associations than bivalents.

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Aug. 19.

[1] Müntzing, A., *Hereditas*, Lund, **23**, 113 (1937), and Myers, W. M., *J. Amer. Soc. Agron.*, **33**, 893 (1941).
[2] Dawson, C. D. R., *J. Genet.*, **42**, 49 (1941).
[3] Tysdal, H. M., Kiesselbach, T. A., and Westover, H. L., *Res. Bull. Neb. Agric. Exp. Sta.*, **124** (1942).
[4] Senn, H. A., *Bibliogr. Genet.*, **12**, 175 (1938).
[5] Thomas, P. T., *Stain Tech.*, **15**, 167 (1940).

Perilobular Spaces in the Rabbit Pancreas

Kühne and Lea in 1882[1] described (but did not illustrate) two kinds of lobule in the rabbit pancreas: (*a*) a lobule smooth on the surface and in which the cell boundaries of the acinar cells cannot be distinguished; (*b*) a lobule irregular on the surface like a mulberry and in which the cell boundaries are quite distinct.

They were able to show that on the introduction of an injection mass into the pancreatic duct of the *living* rabbit it penetrated, even at the lowest injection pressures in the case of lobules of the (*b*) type, by way of intercellular canaliculi into a space situated between the bases of the acinar cells and the membrana propria. Here the mass filled a series of clefts or spaces which made a triangular pattern on the surface of the lobule. Immediately the injection pressure was reduced the intercellular canaliculi closed again. In lobules of the (*a*) type the mass never penetrated beyond the lumen of the alveoli.

In the course of a recent re-examination of the blood supply of the rabbit pancreas a number of preparations were injected, immediately after death, and at a pressure never exceeding 120 mm. mercury, with a carmine-gelatine mass, by way of the thoracic aorta. In these animals certain lobules stood out very distinctly by reason of the presence on the surface of the lobule of a network of sinusoidal-like spaces filled with the injection mass (Fig. 1). The arrangement of these spaces appeared to correspond very closely with the description published by Kühne and Lea. The mulberry-like appearance of these lobules is quite distinct in the photographs (Fig. 2).

A re-examination of specimens of uninjected rabbit pancreas showed that no blood-containing spaces of this nature could be observed, but that occasional lobules presented an apparent capsule of delicate

Fig. 1. SECTIONED AT 30 μ. ONE ATYPICAL LOBULE SURROUNDED BY SINUSOIDAL-LIKE SPACES FILLED WITH INJECTION MASS. NORMAL LOBULES ABOVE AND AT EACH SIDE. ($\times$ *c.* 50.)

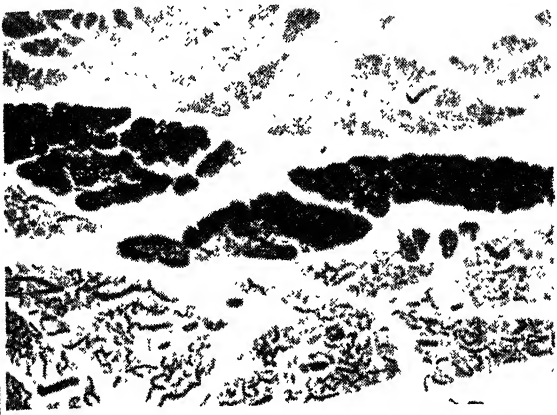

Fig. 2. SECTIONED AT 20 μ. GROUP OF ATYPICAL LOBULES SHOWING THE NET-LIKE ARRANGEMENT OF THE SPACES ON THE SURFACE. ($\times$ *c*. 50.)

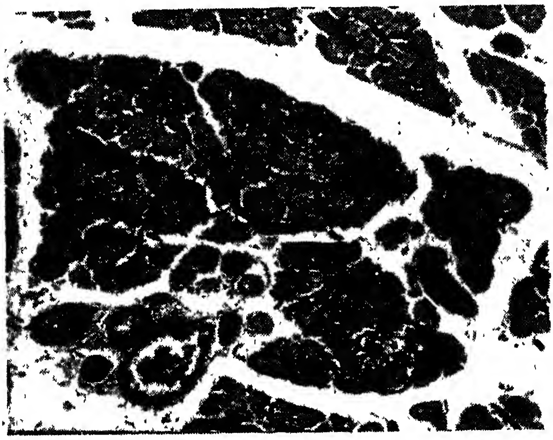

Fig. 3. SECTIONED AT 7 μ. ONE ATYPICAL LOBULE SHOWIN(EXTENSION OF THE PERILOBULAR SPACES WITH CONTAINE] INJECTION MASS BETWEEN THE ACINAR CELLS TOWARDS TH! LUMEN. ($\times$ 120.)

connective tissue between which and the bases of the epithelial c lay a number of large thin-walled capillaries which appeared to confined to the surface of these lobules alone.

It would seem that these spaces, accessible either from the vascı system or from the acinar lumen, might be:

(*a*) Not preformed spaces, but artefacts produced by the irrupt of an injection mass into delicate connective tissue. Their regulaı of pattern and their restriction to certain lobules, and the fact that lobule is completely invested by them, would seem to militate agai this suggestion.

(*b*) Lymph spaces, filled from ruptured blood capillaries, or by v of a ruptured basement membrane from the glandular lumen. T would appear, at first sight, to be the most likely explanation. serial section, however, no extension of the injection mass into lym' atic capillaries presumably draining the space could be detected. I is it easy to see why such spaces should be confined to the minoı of lobules.

(*c*) Spaces which permit the passage of small quantities of exocrine secretion of the gland into contact with special thin-wa capillaries which mediate the absorption from this secretion of fac which are presumably of use internally. It would have to be assu that in the present preparation the spaces have been filled by rupt of the thin-walled capillaries which lie in them. It will be noted t in the photographs the injection mass appears to extend betw some of the acinar cells towards the lumen of the acinus (Fig. Kühne and Lea stress the fact that in the living pancreas the injec mass flowed, with the utmost ease and at negligible pressure, from lumen of the acinus into these spaces. These facts lend suppor the view that the connexions between these spaces and the lume the acinus are present in the living animal. If such be the case th can be little doubt that the function of these connexions is to con some of the exocrine secretion into the spaces.

H. HUGHE

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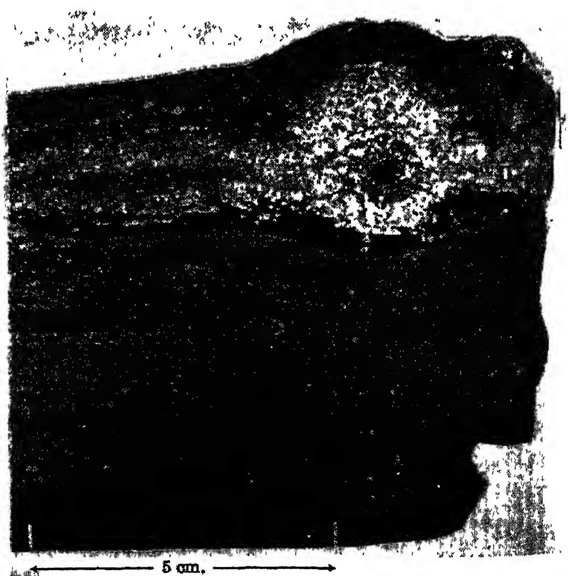
Aug. 20.

[1] Kühne, W., and Lea, A. Sh., "Beobachtungen über die Absonder des Pankreas", Untersuch. physiol. Inst. Univ. Heidelberg, 448 (1882).

magmatic rolls' for this type of structural feature of igneous rocks. These rolls, on weathering, separate themselves into spindle-shaped rods several feet in length and up to 5 cm. in diameter. Some of them are circular in cross-section, but the majority are elliptical. The weathered-out rolls are covered by minute spherulites aligned roughly parallel to the axes of the rolls, and on their upper surface they often have large blister-like swellings, which in section appear as hollow spherulites with cavities lined with quartz and occasionally containing black shining tabular crystals, probably of pyrolusite.

These long spindle-shaped rolls were probably closely packed within the hornstone band, but in their present weathered-out condition they are lying loose on the quarry floor, which coincides with the plane of the lower selvage of the sill with its dip of 20° to the south. The rolls in their undisturbed position are aligned parallel to a gently curving line more or less tangential to the west to east strike of the sill. This fact, taken in conjunction with the evidence presented by the orientation of the spirals within the rolls, suggests that the movement which gave rise to the rolls was directed from the north to the south.

Three interesting problems arise out of these observations. The first is the origin of the rolls. Why, for example, are they restricted to a particular band in the selvage of the sill ? Can it be due to a comparatively lower viscosity of the magma composing this band, which, in its turn, was conditioned by a higher proportion of the volatiles, as evidenced by the formation of hollow spherulites ? Then, if the fluidal planar banding of the adjoining pitchstone was due to a lamellar flow of the magma, why was such a lamellar flow transformed into the turbulent flow exemplified by the spiral structure of the rolls ? Was it due to the differential viscosity of magmatic layers ? And then, assuming that the axes of the rolls represent lineation caused by the plastic flow of the magma, is it possible to compare these structures, as developed in a primary tectonite, with certain



5 cm.

[illegible] SILL, COMPOSED OF A BANDED LITHOIDAL PITCHSTONE AND HORNSTONE (ABOVE), CONTAINING AN IMMATURE MAGMATIC ROLL [illegible] SPIRAL STRUCTURE IN CROSS-SECTION

structures, such as rodding or pencil structure, as developed in secondary tectonites ?

Secondly, there is the question of the crystallization of the magma. There are two types of crystalline forms in the rocks forming the selvage of the sill: minute crystallites (mostly scopulites) and spherulites. Both of them are usually aligned along flow lines, either horizontal or spiral. There is no indication at what stage of the magmatic history the crystallites were formed, but it is quite obvious that the spherulites were formed at a later stage, as they are often formed astride several flow lines of the glassy material. The alignment of the crystalline elements in these rocks suggests that we are here dealing with a case of 'mimetic crystallization', or crystallization conditioned by the strain set up by flow of a viscous magma.

The third problem concerns the formation of late magmatic minerals. Many previously described hollow spherulites and cavities in acid igneous rocks, besides quartz and feldspar, contain also tridymite, cristobalite and fayalite. The last-mentioned minerals have not, as yet, been detected in the cavities of acid igneous rocks of Arran, but the occurrence of manganese oxides in these cavities is rather striking. Were these minerals deposited from late magmatic fluids ?

In conclusion, I would like to thank Miss Doreen Hickling for her help in the field work and Mr. K. Spink for making the photograph of the specimen.

BIOLOGY OF WATER SUPPLY

SOME years ago the British Museum (Natural History) produced a useful publication on the biology of waterworks, giving an account of the different kinds of animals and plants which live and often cause nuisances in reservoirs, filter beds and pipes. Now the Freshwater Biological Association has produced a work on the subject*, approaching it from quite a different angle. Up-to-date knowledge and theory of limnology—the freshwater equivalent of oceanography—has been combined with practical experience of waterworks as a result of a fortunate association of authors. Prof. W. H. Pearsall has brought to bear the resources of research at Wray Castle, with which he has kept in very close touch since its inception; the late Alan Gardiner and Dr. F. Greenshields have contributed much experience from the laboratories of the Metropolitan Water Board. This pooling of resources has produced a handy work which should be of high value to water engineers and others concerned with the provision of pure water supplies. Though concerned essentially with Great Britain, it should also be read overseas, where the biological problems of water supply are likewise coming into prominence.

One aim of the publication is to explain the fundamental basis of the productivity of water as applying to reservoirs, and in consequence a good deal of chemistry and some physics of the aquatic environment are involved. Thus penetration of light and the annual cycle in the stratification of static water are discussed. On the all-important question of algal growth examples are given, chiefly from Windermere and reservoirs filled with Thames water, which enable the authors "to assume with some certainty that the chemical and physical environment ultimately controls the production of algæ in a given body of water". The control is not always direct, because in some cases, "perhaps particularly in the nutrient-rich waters of the Thames type, a burst of algal growth may sometimes cease before any serious depletion of the mineral nutrient in the water has apparently taken place, implying that other factors are important". In a general discussion of biological relations several principles of practical importance become apparent. For example, the avoidance of rooted vegetation reduces the accumulation of nutrient materials in the mud, and the insurance of ærobic conditions in the lower layers of water reduces to a minimum the quantity of nutrients which reach the water from the mud.

There are four main types of water available for supply in Britain. First, the type from deep wells and boreholes is commonly of good quality provided it is not stored in light, but being 'hard' and rich in plant nutrients, it is capable of high productivity if the process of photosynthesis is allowed. Secondly, the calcareous type of surface water, common in southern and eastern Britain, is generally rich in life and requires rigid bacteriological control. Thirdly, the non-calcareous type of surface waters, chiefly found in mountainous areas of the north and west, requires little or no treatment in the best cases, such as those stored in Loch Katrine, Lake Vyrnwy or Thirlmere. Fourthly, the Pennine type of surface water is extremely peaty and is often acid, due partly to smoke contamination; it contains few bacteria and algæ, but often a large zooplankton feeding mainly on detritus. Each of these types of water has its separate problems in biological control.

Particular interest is attached to the ageing of storage reservoirs. When the silt, organic matter, lime and nutrient salts which are carried from the upland soils by streams are trapped in a reservoir, there is a tendency for the fertility of its water to increase. This process is accelerated by the annual increase of organic matter from the dead bodies of plants and animals. There are cases in which a reservoir which contained water of first-rate quality when young has reached a stage of undesirable algal and other productivity after 40–50 years. The principle at which to aim in avoiding this undesirable process is that of cropping the organic matter of the reservoir by some means in order to remove each year an amount equivalent to the annual gain. One method suggested, and often applied, is to remove the organic matter in the form of fish. It is perhaps a pity that this debatable matter of fishing in reservoirs, in which those responsible often require biological guidance, is not discussed at greater length.

The biological process involved in slow sand filtration and the effects of algicides are described. There is also a valuable section on forecasting troubles, but this may be a little disconcerting to water engineers in revealing the complex of biological processes: for forecasting an outburst of algæ, for example, no less than eight methods are given, each requiring skilled biological investigation. Specially useful features are accounts of methods used in biological water examination, some of them not yet described elsewhere. For example, there is an improved version of Houston's original method for determining filterability of water. For estimating the amount of plant and animal plankton, the pigment-extraction method, the

* Freshwater Biology and Water Supply in Britain. By W. H. Pearsall, A. C. Gardiner, F. Greenshields. (Freshwater Biological Association Scientific Publication No. 11, 1946.) Pp. 90. Price to non-members, 4s.

Utermöhl sedimentation method and others are described, and so are various useful pieces of apparatus for obtaining samples. More attention might have been given to the preparation of the illustrations, which vary much in quality and appearance. In one of the most significant graphs the horizontal scale is unfortunately omitted.

E. B. WORTHINGTON

ANTI-REFLEXION AND HIGH-REFLEXION FILMS

OPTICAL systems function best when reflexions at the air-glass surfaces are reduced to a minimum. The purple 'bloom' on lenses, a familiar feature in many types of military instruments, is due to the anti-reflexion or non-reflecting thin transparent film deposited on the surface of the lens in order to decrease the amount of reflected light. Interference between the light reflected at the air-film boundary and the film-glass boundary effects a redistribution of the light energy in such a way that the reflected light is reduced and the transmitted light through the glass correspondingly increased. Both the refractive index of the film, which must be less than the refractive index of the glass, and the thickness of the film are controlling factors[1].

Although chemical methods of coating glasses have been used, the better and simpler method is to deposit the film by the high-vacuum evaporation process, similar to that used for making metal-on-glass mirrors. This process allows easy and fine control of the thickness and uniformity of the film. The usual coating materials are magnesium and aluminium fluorides, with a refractive index approximately equal to the square root of the refractive index of glass.

Semi-reflectors made by depositing thin films of silver, aluminium, rhodium, platinum and chromium on glass by the high-vacuum process are in common use, but they suffer from the disadvantage that a considerable amount of light is lost by absorption in the metal films. In anti-reflexion films the interference effects induced by the thin transparent film redistribute the light so that the reflected beam is reduced in intensity, but this is by no means the only arrangement possible. By suitable choice of the refractive index of the film material, this time greater than that of glass, and of the thickness of the film, the reflected beam can be increased in intensity to any desired value for any colour. The film now acts as a high reflector but with the added advantage that the absorption in the interference film is negligible.

The properties of the first interference film semi-reflectors made by the British Scientific Instrument Research Association have been described by K. M. Greenland[2]. The reflectors consist of single-layer and multiple-layer films. The single-layer film is made from material of high refractive index and has an optical thickness of one-quarter of the mean wave-length of the incident light. This gives maximum reflectivity for light incident within 20° of the normal. An even number of alternate layers of low and high refractive indices, starting from one of low refractive index in contact with the glass, make up the multiple-layer film. The reflectivity for the multiple-layer film is higher than the maximum reflectivity for the single-layer film, and the reflected and transmitted beams are more highly coloured. This selectivity, due to the successive filtering action of the several layers, depends on the relative optical thicknesses of the layers, and by suitable selection of the number of layers, their thicknesses and refractive indices, multiple-layer films of different optical characteristics can be built up.

The optical efficiency, that is, the sum of the reflectivity and transmissivity, expressed as a percentage of the incident light intensity, is practically 100 for the interference films, owing to the negligible absorption. Corresponding figures for evaporated rhodium and chromium semi-reflectors lie between 55 and 70.

No mention is made of the actual material used for the films, but it is stated that the choice of suitable material is naturally limited, in that the substance must be both colourless and of high refractive index, and also, since the film is deposited by the high-vacuum process, must evaporate at a convenient temperature without decomposition and adhere well to glass.

S. WEINTROUB

[1] For theoretical details see Greenland, K. M., *Nature*, **152**, 290 (1943), and for the use with the new optical glasses see Lee, H. W., *Sci. Prog.*, **34**, 533 (1946).

[2] *J. Sci. Inst.*, **23**, 48 (March 1946).

HORTICULTURE OF THE ONION

THE American Plant Life Society (formerly the American Amaryllis Society) has devoted Volume 11 of its yearbook "Herbertia 1944" (1946) to the science and practice of onion cultivation. The largest and probably the most outstanding contribution is a translation by H. K. Airy Shaw of A. I. Vvedensky's "The Genus Allium in the U.S.S.R.". This is a critical description of 228 species of the genus. It is reinforced by a paper on the floristic regions of that large area, by William T. Stearn, who also contributes a scholarly evaluation of the distribution, names, literature, classification and garden-worthy species of *Allium* in the Old World. The same author has translated a key to 85 species, published by Victor de Janka in 1886, and, in a more detailed paper, considers the nomenclature and synonymy of *Allium odoratum* and *A. tuberosum*. This symposium of taxonomy deals with about 38 per cent of the estimated total of 600 species belonging to the genus *Allium*.

H. A. Jones discusses problems and progress in onion breeding. This crop is very sensitive to its environment, and selections should be made in the region where the new variety is to be grown. The technique of crossing onion varieties would demand a preposterous amount of time for emasculation, so in practice male-sterile lines have been propagated clonally. They are then interplanted with a suitable pollinating variety, and pollination is effected by the introduction of flies. Two natural amphidiploids have been found in *Allium* crosses. They have considerable vigour, are highly resistant to onion smut, and should provide useful possibilities for the future. The paper also reviews potentialities of resistance to other diseases. Marguerite G. Toole and A. E. Clarke discuss the chromosome behaviour and fertility of colchicine-induced tetraploids in *Allium cepa* and *A. fistulosum*. The autotetraploids are highly self-sterile, but some seeds were obtained after self-pollination. Further tabulation of male-sterility genes in varieties of the onion is given by T. M. Little, H. A. Jones and A. E. Clarke.

It should not be forgotten that various species of *Allium* are ornamental in the garden, and Sgt. B.

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CONDITIONS OF SURVIVAL: THE MORAL BASIS OF CIVILIZATION

THE debate on the Atomic Energy Commission which was initiated by Mr. Blackburn on the adjournment of the House of Commons on August 2 put into a more hopeful perspective the clash between the Russian and the American proposals, if not entirely dispelling the pessimism engendered by the forthright rejection by the Russians of the Baruch plan for the control of atomic energy. With some reason the insistence by the U.S.S.R. on the unlimited rights of national sovereignty has been regarded as the first step towards the dissolution of the United Nations, and if in fact the Russian attitude is as uncompromising as it first appeared to be, that grim possibility must be faced. No scientific worker doubts that the relinquishing of some degree of national sovereignty is the price that must be paid as an alternative to a scientific armaments race embracing not merely atomic energy but also the equally grim potentialities of biological warfare.

While it is necessary to insist that some abrogation of national sovereignty is essential if atomic energy is not to remain a great menace to our age, it does not seem that the disagreement on the panel of men of science attempting to formulate the question of control in terms of scientific possibilities is as wide as would appear from Mr. Gromyko's words. The Soviet delegate, Prof. Skobetsyn, has not made the same difficulties, and although the report which the chairman of the panel, Prof. Kramers, is drafting may prove extremely cautious, it is likely that the possibility of control—in the sense of assurance against secret misuse of atomic energy—at several stages in the development of atomic energy will be clearly indicated. The report will probably leave it to the politicians to resolve the problems involved in the adoption and administration of specific controls.

Mr. Blackburn's speech in the House of Commons suggested that the Russians had not rejected in any circumstances the idea of any form of inspection. Their point was that at the outset the nations of the world should abolish all recourse to atomic bombs by a formal act, and Mr. Blackburn urged that it was inconceivable that the working of any system for the control of atomic energy, once agreed upon by the Security Council, could remain dependent on any act of the Security Council itself. If we established a system of control which gave warning months in advance of the fact that a country which purports to be accepting the rules laid down is violating those rules, we could eliminate the political problem of the veto. Mr. Blackburn indicated his own belief that a careful study of the technical side of the problem showed that possible measures for the control of atomic energy were possible because they turned largely upon scientific considerations, and in spite of asserting that the wider political issues had been considered first, he appears to lean very much to the proposals of the Acheson–Lilienthal report itself.

There was little support for Mr. Blackburn's suggestions in the debate, although the point he made

about the effect of the proposals on the U.S.S.R. and the necessity for removing Russian suspicion if possible was appreciated. The importance of the distinction between disclosing full information regarding the technical aspects of the production of the atomic bomb itself to a super-national authority such as the Lilienthal Commission proposed, and imparting it to such a body as the United Nations Organisation was apparently appreciated, but the note of urgency which has been so firmly emphasized in almost every communication from the scientific side was lacking even in Mr. P. Noel-Baker's statement. Mr. Noel-Baker did not think that a solution would be quickly reached, but made the rather surprising statement that the Government believed that the American and the Russian plans required to be fused. The two proposals, he suggested, really dealt with different parts of the subject, and he did not think they were in conflict. The Russians proposed that the manufacture and use of atomic energy for war-like purposes should be outlawed and that every State should undertake neither to manufacture nor to use the atomic bomb. Mr. Noel-Baker said further that the American representative on the Commission had agreed with the Russian representative that there was no fundamental clash of principle between this and the American proposal.

Mr. Noel-Baker's chief observations, however, were on the question of control and inspection. The Government fully accepted the principle of control and believed that a practicable scheme could be devised which would give reasonable security. Agreeing that the start should be made from the technical side, Mr. Baker said that, in the Government's view, we should first aim at drawing up a practical plan in the form of a convention for the creation of an international authority, and that, having done this, we would come to the necessity for political decisions. Before the major decision was taken the governments should have time for reflexion, the benefit of a prolonged international debate and a concrete picture of the safeguards offered in return for the surrender of sovereignty which the plan would involve.

In reply to a question as to whether the technical commission which is to work out this scheme would also deal with scientific subjects and the interchange of information, Mr. Noel-Baker said that members of the Atomic Energy Commission were not primarily men of science, but on the scientific and technical committee there were some of the most eminent men of science in the world. Besides this there was a sub-committee, mainly political, dealing with the system of control. He thought it possible that there might be agreement on exchange of scientific information before any final convention was made; but he emphasized that while men of science as such had rendered great assistance for pooling and publishing information, directing attention to the main problems to be solved and suggesting lines on which a solution might be found, they could not assume the political responsibility which must remain with the Government. Finally, Mr. Noel-Baker agreed that the atomic bomb might be neither the last nor the worst weapon which science might produce. We had to deal with armaments of all kinds and should make it our object of policy to stop all wars, as well as to remove the causes of war.

Much of Mr. Noel-Baker's statement is most reasonable and in accord with scientific opinion. His recognition that the surrender of national sovereignty is involved is clear enough, though it might well have been emphasized more strongly that without such surrender there can be no control and no alternative to atomic warfare. The fate of the Kellogg Pact alone indicates the futility of relying simply on the renunciation of a particular type of warfare. But while it is reasonable and important that the governments should have ample time for reflexion before they make their decision, it should also be recognized that time is an essential element in reaching a real solution. The problem may well become more intractable, if not insoluble, by delay, as the Lilienthal Board have urged. There is grave danger that dilatoriness may allow an international atomic armament race to attain such momentum that it cannot be stopped.

Mr. Noel-Baker's statement did nothing, therefore, really to dispel the fear that the question of atomic energy and its control is not regarded by the Powers with the sense of overriding urgency that is imperative, and this fear will not be diminished by a like failure of the Powers to face the issues involved by the termination of the United Nations Relief and Rehabilitation Administration on December 31. Despite the proved and known need, despite the fact that the World Health Organisation will not meet until January and that the transfer to the Food and Agricultural Organisation of the functions of relief and agricultural rehabilitation, as recommended by the Director-General of U.N.R.R.A., will take a long time, liquidation of the headquarters staff of U.N.R.R.A. has already begun. The World Health Organisation will meet to find that the body of experts uniquely qualified to serve its high purposes of mitigating disease has just been finally dissolved, and the Committee to which the Food and Agricultural Organisation has referred the practical difficulties of finance and organisation and of principle involved in the transfer, is apparently not to report until the existing organisation has been wound up, and no plans can be approved to operate in time to meet European needs in the closing months of the present harvest year.

This melancholy picture of failure to face facts and to make adequate transitional arrangements to meet needs which are ultimately to be provided by organisations still in their birth throes encourages no easy optimism regarding the willingness or ability of governments to deal with the problem of atomic energy. It is indeed a picture of moral dereliction as well as ineptitude, and however right Mr. Noel-Baker may be in emphasizing the responsibility of the Government for the political and administrative action required, it is equally right that men of science having discharged the technical responsibilities that lie on their own shoulders, should leave their fellow citizens in no doubt as to the dereliction of duty for which the Powers can justly be arraigned.

That dereliction of duty is not one in which the British Government stands alone. We may gladly recognize that in regard to atomic energy the Government of Great Britain has taken a lead, and especially in insisting on the limitations of national sovereignty that are involved in any effective plan for control. But it is not sufficient merely to indicate acceptance of those implied limits on national sovereignty. That of itself will not place the responsibility for failure solely on the shoulders of those who primarily reject any such limits, unless every step has been taken to engender the confidence which would encourage the surrender by other nations of the necessary degree of national sovereignty.

Mr. Blackburn was right to indicate the responsibility which in this matter lies especially on the United States if Russian co-operation and confidence are to be secured, but nothing in the debate touched on a more fundamental responsibility of both Great Britain and the United States which is brought out even more clearly in relation to the dissolution of U.N.R.R.A. and the work of the Control Commission in Germany. The dominant factor in the present unsatisfactory position is the absence of a firm long-term policy for the whole of Germany. The most emphatic and important conclusion which the Select Committee on Estimates reached in its report on the Control Office for Germany was the need for the economic re-integration of the zones of occupation and the formulation of such a firm long-term policy; if not, in default of re-integration of the zones, for the whole of Germany then for the British zone and for such other zones as may be brought within the framework of a single economy. Fairly and squarely there was thus placed on the shoulders of the British Government the responsibility for formulating such a policy for the zone which it controls, and no refusal by the American Government or by the U.S.S.R. to face those facts and accept those responsibilities can excuse British refusal to honour the moral obligations implicit in the Atlantic Charter.

What has to be faced is that in deference to the U.S.S.R., Great Britain and America have abandoned the principles involved in the Atlantic Charter and have left themselves without any consistent peace aims. Abandoning the ideals and values of Western civilization, they have failed to practise them; and each successive challenge in Europe, whether of famine, of health, of economic reconstruction, no less than of the control of atomic energy, has found them with nothing positive to oppose to the aims and values of Soviet Russia. The first need for Britain and for the Western democracies is a positive policy based on those principles and ideals which are the highest expression of our Western civilization and which we professed only five years ago. If those values and principles are practised we may recapture the moral purpose and formulate the policies which can give them adequate expression.

Nothing is gained by concealing the fact that the aims and values of Soviet Russia are not those of Western Europe, or that what is needed to restore unity is a revival or a re-assertion of the religious standards and way of living from which Western civilization has derived much of its greatness. Respect for human personality, freedom of thought and utterance, freedom of worship, freedom of investigation—these freedoms from want and from fear in the spiritual realm are exactly what are denied by communism and cherished by the Christian ethic. They are also the conditions of scientific investigation and are implicitly asserted in the resolutions recently adopted unanimously by the General Assembly of the International Council of Scientific Unions.

These resolutions point to the supreme opportunity and occasion for a new international unity, to develop the benefit latent in nuclear energy and to avoid its misuse and no less to avert the potential menace of biological and biochemical warfare and to bring to mankind the full benefits of the discoveries on which such warfare depends. The resolutions recognize clearly that attainment of an agreement on the application of nuclear energy would represent an example of the international co-operation in economic and political matters which is essential to promote the welfare of mankind, the judicious use of natural resources, the removal of causes of dispute and the settling of difficulties arising from the continuous change of world conditions in consequence of scientific and technical advances. They recognize also that military secrecy cannot be allowed to dominate scientific discovery in any country or to prevent frank discussion and open publication of scientific results: international control and co-operation presuppose an international community of knowledge.

EARLY MAN AND APES IN THE FAR EAST

Apes, Giants and Man

By Franz Weidenreich. Pp. vii+122. (Chicago: University of Chicago Press; London: Cambridge University Press, 1946.)

MORE than fifty years ago there were discovered in Pleistocene deposits in central Java the fragmentary remains of a large primate which in several respects appeared to be intermediate between man and ape. It was therefore named *Pithecanthropus*. But, because the remains were so fragmentary, they led to a considerable amount of controversy which, on the whole, was rather inconclusive. Then, in 1929, the skull cap of a Pleistocene primate similar to *Pithecanthropus* was found in China near Pekin. It was described by the late Dr. Davidson Black and named by him *Sinanthropus*. Finally, during the few years preceding the Second World War, many more skeletal remains of these fossil forms came to light both in China and Java. Indeed, at present there are records of five skulls of *Pithecanthropus* (including that of an infant) from Java and no less than fifteen skulls of the Pekin fossil, as well as jaws and teeth and some limb bones. Thus we are now in a position to speak with some confidence on the morphological characters of these ancient forms.

One of the anatomists who have been most active in the accumulation of this new evidence is Dr. F. Weidenreich, who succeeded Davidson Black in 1934 as professor of anatomy in the Pekin Union Medical

College, and who during recent years has been responsible for the publication of a series of exceptionally fine monographs on *Sinanthropus*. Before the War, Dr. Weidenreich also maintained a close contact with Dr. v. Koenigswald, of the Geological Survey in Java, to whose energy and initiative the new discoveries of *Pithecanthropus* in Java were mainly due, and he was thus able to make a personal study of some of this valuable material. Specialists will already be well acquainted with Weidenreich's monographs published in scientific journals on these Chinese and Javanese fossils. Some of the results of his important studies have now become available in more popular form in a short book of essays published by the University of Chicago.

The first important point which has accrued from these studies is that the resemblance between the Chinese and Javanese fossils is very close, so close, indeed, that they are reckoned both by Weidenreich and v. Koenigswald to differ no more than two races of modern mankind. It is generally agreed by systematists now that this conclusion is certainly correct, and that *Sinanthropus* should really be allocated to the genus *Pithecanthropus* (though possibly with specific distinction). Weidenreich himself is reluctant to do this, since he thinks that such a change would be confusing. But it may be argued with reason that the retention of an implied generic distinction now recognized to be unwarranted would be even more confusing, for whereas in one case the confusion would be at the most a temporary inconvenience, in the other case it would be a permanent source of misapprehension.

The outstanding features of *Pithecanthropus* in Java and China can be stated quite briefly. Many of the skull characters are remarkably simian, including heavy projecting supra-orbital ridges, retreating forehead, marked platycephaly and massive jaws. At the same time, the teeth, though showing several primitive features, are human in their individual morphology and their general arrangement, and the temporo-mandibular joint is also constructed on the human plan. The cranial capacity is astonishingly variable, ranging from 750 c.c. to 1,200 c.c., and at its upper limits, therefore, comes well within the range of *Homo sapiens*. Lastly, the few available limb bones appear to be identical with those of modern man. It thus appears that *Pithecanthropus* was definitely a human being, though in some respects exceedingly primitive.

Among the Javanese fossil remains was found a fragment of a lower jaw containing the two premolar teeth and the first molar. The discovery was announced by v. Koenigswald early in 1941, and a cast of it was sent to Weidenreich (then in the United States). It was derived from the Trinil beds, and, because of its massive proportions, was named by v. Koenigswald *Meganthropus*. In its general features this jaw fragment appears to conform with a *Pithecanthropus* mandible discovered some years previously, though definitely larger. Whether its size really does put it beyond the range of variation of *Pithecanthropus*, and therefore justifies a generic distinction, can scarcely be affirmed with confidence until more fossil material becomes available. In any case, however, it may be somewhat misleading to refer to the owner of the *Meganthropus* jaw as a 'giant', since the latter term is commonly taken to indicate an unusual stature. All the known jaws of *Pithecanthropus* are massive as compared with those of a modern European, yet, so far as stature is concerned, it is to the latter rather than the former that the term 'giant' might be more appropriately applied. Dr. Weidenreich includes among his 'giants' three molar teeth which were acquired by Dr. v. Koenigswald in Chinese chemists' shops in Hong-Kong. (It should be explained that fossil teeth are not infrequently to be found on sale in China under the name of 'dragons' teeth', and they are assumed to be of therapeutic value.) v. Koenigswald expressed the opinion that these were the teeth of an extinct ape of exceptionally large size, probably nearly related to the orang-utan, and he called it *Gigantopithecus*. Weidenreich, although he has only had access to casts for the study of these specimens, believes they are the teeth of a gigantic hominid. Here, however, we are quite unable to follow him. It appears to us that none of the morphological criteria on which he relies for his diagnosis are completely valid, and that the simian appearance and proportions of the teeth far outweigh in significance any suggestion of hominid traits which the teeth may seem at first sight to show. We would therefore agree with v. Koenigswald's point of view, particularly since Weidenreich has already stated specifically elsewhere that the *Gigantopithecus* molar closely resembles a fossil orang's molar from Kwangsi in south China in the form, number, arrangement and height of the cusps, as well as in their tightly set condition (*Anthrop. Papers Amer. Mus. Nat. Hist.*, 40, Pt. 1; 1945).

The accumulation of fossil primate material bearing on human origins is now proceeding rapidly, and it is becoming apparent that the number of forms of ape and man which existed in late Tertiary times reached a diversity hitherto quite unsuspected. One of the remarkable features which has been made evident by all these fossil remains is that they frequently present unconformities which would certainly not have been anticipated. Among such unconformities is the association of the peculiarly primitive skull and jaws of *Pithecanthropus* with delicately modelled limb bones of modern human type, and the association of a simian skull with teeth of human proportions in the Australopithecinæ. Incidentally, such odd associations greatly weaken the arguments of those who still refuse to accept the possibility that the Piltdown jaw and skull may belong to the same individual.

Another point of interest which is now beginning to emerge very strongly is that, so far as the actual *origin* of man is concerned, Africa is likely in the future to be the main focus of attention for palæontologists, and not Asia. For, as already mentioned, *Pithecanthropus* is definitely human, and in some respects is rather far removed from the ape. On the other hand, the fossil primate material reported from Africa by Dart, Broom, Leakey and MacInnes seems to bear witness to actual transitional forms between ape and man.

W. E. LE GROS CLARK

A BUDGET OF ERUDITION

Essays and Studies

By W. A. Osborne. Pp. vii+188. (Melbourne, Sydney and Adelaide: Lothian Publishing Co. Pty., Ltd., 1946.) 10*s*. 6*d*.

ABOUT a century ago, De Morgan, the mathematician, was contributing articles to the *Athenæum*, describing the various attempts which had been made to invent perpetual motion, to square

the circle, or to trisect the angle. These articles, along with many items gathered from his varied and extensive reading, were included in his "Budget of Paradoxes", a book which, as reprinted by his widow in 1872, is one of those books still beloved by readers who are interested not only in the highways but also in the by-ways of literature. The book is a marvellous combination of versatility and accuracy.

These thoughts about De Morgan, the mathematician of a century ago, came unbidden to the mind of the reviewer as he slowly turned the pages of Osborne, the physiologist of the present day. Parenthetically, it may be remarked that Dr. Osborne was born in Ireland and received his early education there, and later at University College, London, and at Tübingen. For some time he taught physiology in London, but he became professor of physiology at the University of Melbourne in 1902, and dean of the Faculty of Medicine during 1929–38, and is now emeritus. Just to call him a physiologist, however, is as inadequate as it would have been to call De Morgan a mathematician. Osborne's interests are astoundingly wide and varied, including highly original and often amusing comments on Shakespeare's language, a detailed description of the price-fixing and wage-fixing edict of Diocletian in A.D. 301 (conveying a lesson to us from the past), and the true place of science in education. The publishers of the book are justified in saying that the outstanding qualities of these essays is originality based on accurate scholarship, and the reviewer feels justified in calling the book "A Budget of Erudition".

Some of the most entertaining instances of Osborne's erudition occur in the essay on "Scientific Errors in Literature and Art". Here he shows himself no hair-splitting pedant. He disapproves of the mathematician who rebuked Tennyson for stating "Every moment dies a man, every moment one is born", and who suggested the correction "one and a sixteenth is born". He pounces only upon real 'howlers'. Rider Haggard in "King Solomon's Mines" has an eclipse of the sun lasting over an hour, whereas the maximum time is seven minutes. Wordsworth in his poem on the green linnet makes that bird "pour forth his song in gushes", but, alas ! the green linnet is a songless bird. In Lever's "Charles O'Malley" a horse crashes badly and breaks a collar-bone, but a horse has not got a collar-bone ; and when Browning in "How We Brought the Good News" makes a rider in full gallop shake off his jack-boots to lighten the load, one wonders, says Osborne, if Browning ever wore jack-boots or ever rode a horse.

The reviewer is compelled to pick and choose from the contents of this book. Time and space would fail him to enlarge on such attractive themes as "The Magic of Monosyllables", the sort of dial that Shakespeare had in his mind's eye when he wrote that Touchstone "drew a dial from his poke", the Voices of the Great—with its stories of Dickens and Gladstone and Spurgeon, whose Tabernacle was attended by an educated visitor to London because of "the incomparable melody" of the speaker's voice. The short essay on "Old Age Then and Now" is a sharp reminder of demographic facts and their economic significance. "Old John of Gaunt, time-honoured Lancaster" died at fifty-nine. Columbus, according to Walt Whitman, "a battered wrecked old man", died at fifty-six. Thackeray, who described himself in one of his poems as a "grizzled grim old fogy", died at fifty-two. History does, of course, adds Osborne, give us examples of illustrious men dying at great ages, but they are regarded as prodigies surpassing Nature's law. Now they are no longer so, the span of life in all classes of the community has increased, and at the other end infant mortality is no longer regarded as philosophically as it was a generation ago. The essay on "Science in Education", being an address delivered at an All-Australian Education Conference, is a most careful and illuminating piece of work. The essayist is equally clear and plain-spoken as to what science can do, and what it cannot do, for the young learner ; and, as may be abundantly gathered from his other essays, he is far too good a humanist to be a one-sided advocate of science in education. He denounces bad teaching, whether of science or of literature, with equal clearness and emphasis wherever he sees it. He impeaches the grammarians of destroying the appreciation of literature. A play of Shakespeare is prescribed and an examination is held, and most of the children "thus affected and afflicted acquire an abiding aversion to this drama and sometimes to its great author just because a work of art has been put to a use to which no work of art should ever be applied". Thus does Dr. Osborne again prove himself to be much more than an eminent physiologist.

T. RAYMONT

ATOMIC PHYSICS

Introduction to Atomic Physics
By Dr. Henry Semat. Revised and enlarged edition. Pp. xi+412. (New York: Rinehart and Co., Inc., 1946.) 4.50 dollars.

THERE is a real need for text-books covering a self-contained lecture course on atomic physics. By departing drastically from the historical order of development, a very wide ground may be covered even with students at a comparatively early stage. It is possible to make such a course relatively simple to follow and yet to include most of the important features of modern atomic, including nuclear, physics. The developments associated with atomic energy have raised the educational requirements for this branch of physics, so the demand for appropriate text-books should be considerable.

Dr. Semat's book is of this type and includes a well-balanced choice of subject-matter. The mathematics introduced is never difficult, requiring little more than a knowledge of elementary calculus. Part 1 deals with the foundations, Part 2 with the extra-nuclear structure of the atom and Part 3 with the nucleus. It is written in an easy, but not hearty, style, is well illustrated and is quite up to date. Thus it includes a discussion of the betatron and of nuclear fission. In fact, discussion of the nucleus is very thorough and would provide an excellent introduction to the subject.

At the end of each chapter useful references to other texts are given, together with another valuable feature—the provision of problems on the subject-matter of the chapter. These are well chosen and likely to assist the student to clarify his mind.

Tables of atomic weights, isotopic masses and stable isotopes are included among other appendixes.

The form and style of the book are pleasing, and it should be of much value to teachers of atomic physics in Britain.

H. S. W. MASSEY

The Countryman's Week-End Book

By Eric Parker. (Week-End Library.) Pp. 416. (London: Seeley, Service and Co., Ltd., 1946.) 12*s*. 6*d*. net.

ERIC PARKER is well known as a writer on natural history for his ability to interpret natural lore in language which makes it freely available to all. Here he has attempted to produce a book especially for leisure hours, and has been very successful. It is meant to be a book for any odd ten minutes and for reading both forwards and backwards. Its merit is that no matter where one dips there is something of interest to while away the awkward moment before one's next engagement.

There are sections on building a house and the best wood for wood fires, and the best creepers and climbers. Parker will advise on the choice and care of a dog, while on the recognition of birds and the way to entice them to the garden he overleaps himself to be helpful. British mammals, reptiles, insects and wild flowers form other parts of this conversation in words, while, to take a different tack, he provides some useful and revealing information about country crafts and industries. Nor is he afraid to offer advice on forecasting the weather, or what books could be read with advantage on country matters. Even his facts about the record weights of fish and birds and the sports records of athletes do not exhaust this compendium for the aspiring countryman, for his final section includes a valuable account of the legal snares which await the innocent townsman taking up country pursuits. In simple terms Parker explains the Game Act of 1931, how and when and what to shoot, the laws that must be observed when engaging fish or domestic servants, as well as the law of trespass. And, lest the man of science thinks that this is a scrappy collection of superficial miscellanies, let him be reminded that Parker's information has been collected in a life-time of acute observation in the country. During that period he has used a discerning eye to note the kind of information which interests most men and women, and "The Countryman's Week-End Book" is an interesting record of his discrimination.

T. H. HAWKINS

Electric Discharge Lighting

By F. G. Spreadbury. Pp. viii+136. (London: Sir Isaac Pitman and Sons, Ltd., 1946.) 15*s*. net.

THE title of this little book is misleading. It deals not at all with the principles or practice of lighting, but is merely an account of some of the properties of modern electric discharge lamps. In the last fifteen years, the search for high luminous efficiencies and coloured light sources has led to rapid development of these lamps, and there are now about a dozen principal types available commercially in Great Britain. The author, therefore, in the small amount of space at his disposal, has clearly attempted to give only a very superficial treatment of what is now an extensive subject.

Judged in this light the book has merit. Chapter 1, on fundamentals, is clear and concise; although there are some mistakes, it will serve as the sort of introduction to the subject required by a layman. There follow three chapters in which low-pressure lamps (both cold-cathode and hot-cathode types), high-pressure mercury vapour lamps, sodium vapour lamps and fluorescent lamps are dealt with. While the next two chapters, concerned with circuits and the design of circuit components, are not free from fault, they provide in a clear manner information that many readers will find useful and interesting.

The last chapter is called "Technical Applications of Discharge Lamps"; the reviewer can only wonder why this was written and how it found its way into a book on lamps.

Those who have no special knowledge of the subject, but have a general interest in knowing something about the discharge lamps which are being increasingly used for lighting, will probably find the book suitable for their purpose. It is not recommended for those who require anything more than a very general introduction to the subject. The production is good and the figures and diagrams (122 in all) are excellent, but the almost complete omission of references detracts from the value of the book even for the general reader.

V. J. FRANCIS

Heaviside's Electric Circuit Theory

By H. J. Josephs. (Methuen's Monographs on Physical Subjects.) Pp. viii + 116. (London: Methuen and Co., Ltd., 1946.) 4*s*. 6*d*. net.

IN following the standard set in this series of monographs, the author gives us a tidy, critical, and slightly historical account of the basis of operational calculus as devised by Oliver Heaviside. It should be a great help to students, because it is in the initial stages that the difficulties are most severe. There is a slight parallel between Heaviside and the author, for the latter, without paper qualifications, has risen to be an effective exponent of his master's subject, a corner of the field of mathematics which is not densely populated by authors.

Indeed, Mr. Josephs seems to have read more deeply into the works of his master than others, for he has found a new theorem, "Heaviside's Last Theorem", which he shows to be a unifying theorem for much other work, including Carson's integral equation and the rigorous derivation of the remaining Heaviside operational processes of use in electric circuit theory.

L. E. C. HUGHES

The Warlis

By K. J. Save. Pp. x+280+15 plates. (Bombay: Padma Publications, Ltd., 1945.) 10 rupees.

THE Warli tribe is a branch of the better known Bhil tribe, and this account of it by the Special Officer for the Protection of Aboriginal and Hill Tribes in the Thana district of Bombay is for practical purposes an excellent factual account of a primitive tribe slowly being absorbed into Hinduism. Though the Brahman is beginning to take the place of the tribal priestess, the power of the tribal shaman is still very great, and in the opinion of the author is no less a stumbling block to progress than the Warli love of drink and their economic depression to the position of landless labourers living from hand to mouth. The author deals in detail with the daily life, society, organisation, mythology, religion and language of the tribe and incidentally with their material culture. In so far as it is documentary, as distinct from interpretative, the account given is commendable and thorough. There are forty-three photographs, but unfortunately reproduced on too small a scale to be really satisfactory, an index and a glossary; there are also a few text cuts, but no detailed drawing of the rather remarkable hornpipe, the favourite musical instrument of the tribe. Except for rather too numerous misprints and misspellings, the printing is good. The author is to be congratulated on a painstaking piece of very useful ethnographical work.

On the Choice of a Common Language

Edited by H. Jacob. Pp. xiv+130. (London: Sir Isaac Pitman and Sons, Ltd., 1946.) 7*s*. 6*d*. net.

ANYONE who has listened patiently to radio accounts of proceedings at the Peace Conference must have fresh in his mind the prodigious expenditure of time, and sometimes the shocking confusions and misunderstandings, caused by what one of the contributors to this book calls "these linguistic difficulties which have cursed mankind since Babel". Here is sufficient proof that something needs to be done about it.

The aim of this book is to show that a common language is not only an urgent need, but also a practical possibility. It is produced under the auspices of the New Education Fellowship, an organisation which is too well known to call for description or commendation in any educational journal. In the first part the writer gives a short history of the constructed languages, such as Volapuk and Esperanto. The second part is devoted to an exposition of Basic English, its meaning, its principles, and its educational value. The book as a whole comes down definitely on the side of Basic English as the simplest and most promising way of meeting the need of the peoples of the world for international communication, now that the nations are inevitably drawn closer together. The book is packed with reliable information, and is a credit to its writers.

The Statesman's Year-Book

Statistical and Historical Annual of the States of the World for the Year 1946. Edited by Dr. M. Epstein. Eighty-third annual publication, revised after Official Returns. Pp. xli+1,461. (London: Macmillan and Co., Ltd., 1946.) 30*s*. net.

THIS valuable year-book again provides the official statistics for every country of the world. For some of the belligerent States of Europe revised figures are at last available. For the main enemy countries, however, that is not yet possible. The frontier changes in eastern Europe contemplated at the Berlin Conference of July 1945 are shown in a coloured map—the allocation of the Polish corridor, East Prussia, Bessarabia and Bukovina, with the western spread of the U.S.S.R. A second map shows the changes indicated by the Potsdam proclamation to Japan, including the return of Manchuria and Formosa to China, of Karafuto and the Kurile Islands to the U.S.S.R. and the independence of Korea. The section on the League of Nations is replaced by one on the United Nations with the complete text of the Charter. The British Council is also noticed. The volume retains unchanged its compact shape and size and high standard of production.

Self

A Study in Ethics and Endocrinology. By Michael Dillon. Pp. vi+128. (London: William Heinemann (Medical Books), Ltd., 1946.) 6*s*. net.

THE ancient precept, inscribed in gold letters over the portico of the Temple at Delphi, is rendered into English as "Know Thyself". This precept is adopted as a motto by the author of "Self: a Study in Ethics and Endocrinology". Mr. M. Dillon is the author of the book, and Dr. Gilbert Russell writes a commendatory but cautious foreword. The author sets himself the question: Why is a man what he is? The beliefs, tastes, hobbies, eccentricities, which build up the normal man or woman, are the origin of the disorders which develop if any trait gets out of perspective. This book is an attempt to discover how far the character of the individual depends (the words are important) upon physical structure and the chemistry of the body. The author examines the difference of outlook between the two sexes, how this difference arises and what it implies. In discussing, in the second part of the book, the mind, he necessarily deals with the problem of free-will, and this brings him to a synthesis of science and philosophy as a guide to man's understanding of himself.

All things considered, the book is simply written, but for the less initiated the author thoughtfully adds an explanatory vocabulary. He concludes with a bibliography and a reference to papers on the subject.

The Photography of Scenery

By Dr. Vaughan Cornish. Pp. 129. (London: Sifton Praed and Co., Ltd., 1946.) 12*s*. 6*d*. net.

DR. VAUGHAN CORNISH has not infrequently charmed us with his studies of beautiful things, sometimes natural and sometimes man-made. Now he provides another collection, from his camera this time, with a promise of some sketches to follow.

Apart from the technically high level which is achieved, the appeal of these photographs resides to a considerable extent in the sense of tranquillity which many of them produce. That is very valuable in these days of riotous movement. For example, No. 22 (banyan tree) is almost a Blake drawing in essence, rhythmic yet reposeful. The architectural studies, Wells for example, are very successful in their own way and manage to convey characteristic local atmosphere. When all this is presented in an attractive little book, one goes on one's way rejoicing that there is still somebody who values scenery intensely and wants other people to do so too.

F. IAN G. RAWLINS

Karlova Universita

(The Charles University). By Prof. V. Vojtíšek. Pp. xii+130. (Brno: A. Píša, 1946.) 84 crowns.

PROF. VOJTÍŠEK is archivist to the city of Prague, and his object is to emphasize the Czech origin of the city's University. This he does by reproducing and explaining the early documents relating to its foundation. These are Pope Clement's Bull of 1347, Charles IV's "Golden Bull" of 1348 and his endowment charter of 1349. The 1401 and 1402 reports of the then dean (Magister John Hus) are given together with the legal observations of 1414 on Wenceslas IV's 'Kutná Hora' decree reiterating the precedence of the Bohemian 'nation' in all university affairs. The need to establish the facts relating to the origin of the University has arisen as a consequence of the German action during the occupation of transferring the privileges and possessions of the University to the German University of Prague.

Rostlina pod Drobnohledem

(The Plant Under the Microscope). By Prof. S. Prát. Pp. 206. (Prague: Česká Grafická Unie, 1945.) 99 crowns.

THIS is a new text-book of structural botany for Czechoslovak university students. It is noteworthy for the excellence of the author's photographs of microscope preparations.

BIOCHEMICAL RESEARCH ON CHEMICAL WARFARE AGENTS

By Dr. M. DIXON, F.R.S., and Dr. D. M. NEEDHAM
Department of Biochemistry, Cambridge

THE fundamental mechanisms by which poison gases produce their effects, involving as they do the action of chemical substances on living tissues, are primarily a matter for investigation by the biochemist. For some time past the belief has been growing that many, if not most, poisons act by attacking one or more of the essential intracellular enzymes, thus producing what Peters has termed a 'biochemical lesion'; the actual damage observed is a consequence of the resulting metabolic disturbances.

At the time of the Munich crisis in 1938, when war seemed imminent, we put forward suggestions for work on these lines, involving a study of the action of war gases on enzymes. These suggestions were not then proceeded with, but on the outbreak of war a year later they were renewed, and early in 1940 a research team under the direction of Dr. M. Dixon was formed to work in this laboratory for the Chemical Defence Research Department of the Ministry of Supply. This article gives a brief account of this team's work, which extended from 1940 until 1945; it will be seen that although attention was especially focused on mustard gas, the work was not confined to the problem of vesication, but developed to include other problems, such as the mechanism of systemic mustard and lewisite poisoning, of lachrymation, of the action of myotics, etc. Some of the later work on mustard gas was done in collaboration with Prof. Wormall's team, which was evacuated to Cambridge from London during the War.

It was soon found that (*a*) the different classes of substances (lachrymators, vesicants, myotics, etc.) do, in fact, poison different groups of enzymes, and (*b*) different substances belonging to the same class in general poison the same enzymes, even though they may have very different chemical constitutions. This gave strong support to the view that these poisons act primarily by a specific attack on enzymes.

Lachrymators

These are of two types, containing respectively halogen atoms and $>C=C<$ groups. In the first group, it was already known that lachrymatory properties were associated with the presence of a 'positive halogen', for example, in a grouping such as

$$\overset{\nearrow O}{\underset{}{\|}}$$
$-C-CH_2X$, and Ford Moore[1] had correlated activity with chemical structure on this basis with considerable success. It was not known, however, why the positive halogen should confer these properties, why such properties should also be shown by substances of the second group, or what kind of chemical reaction was responsible.

In 1941 a survey by Mackworth[2] showed that lachrymators irreversibly inhibited all those enzymes the activity of which had already been shown by independent evidence to depend on —SH groups. Among these were succinic dehydrogenase, triosephosphate dehydrogenase, yeast alcohol dehydrogenase, hexokinase, the pyruvate oxidase system (of bacteria), papain and urease. Xanthine oxidase was also sensitive and hence probably should be classed as an —SH enzyme. A large number of other enzymes tested were not affected. Mackworth therefore suggested that lachrymators act by a specific attack on essential —SH groups.

There is other evidence supporting this. (*a*) Morgan and Dixon[3] showed directly by means of the nitroprusside reaction that the lachrymators of both groups attack the —SH groups of proteins very rapidly and completely. Mustard gas (*H.*) also reacts with protein —SH groups very slowly[4]; but the rate is quite negligible in comparison[3] and mustard reacts mainly with other groups in proteins. It does not affect most —SH enzymes under similar conditions. (*b*) —SH enzymes are inhibited by lachrymators only in the —SH form; the oxidized (—S—S—) forms are not inactivated[2,5]. (*c*) Peters and his colleagues[7] had shown that arsenicals such as lewisite can combine reversibly with —SH groups in enzymes, and van Heyningen[5] found that if hexokinase is first inhibited by lewisite, then treated with a lachrymator, and finally treated with *B.A.L.* (British anti-lewisite) to remove the lewisite, no inactivation occurs. The —SH groups are masked by the lewisite and so the enzyme is protected against attack by the lachrymator. (*d*) The use of a lachrymator of the halogen type (for example, *C.A.P.*) in the presence of bicarbonate gives a valuable method for estimating —SH groups in proteins: each *C.A.P.* molecule reacting liberates 1 acid molecule, thus:

$$C_6H_5.CO.CH_2Cl + HS.R = C_6H_5.CO.CH_2.S.R. + HCl,$$

and the CO_2 liberated thereby can be measured manometrically[8]. The results agree with those given by other methods. Ovalbumin, with no —SH groups, gives no immediate reaction; but after heat denaturation, which liberates —SH groups, it reacts immediately and the results agree exactly with the accepted values. (*b*), (*c*) and (*d*) afford strong evidence that, at any rate in neutral aqueous solution, the lachrymators react only with —SH groups in proteins. The lachrymators have in fact given us a means of identifying —SH enzymes which is much more reliable than any test previously available.

Dixon[9] considered the chemistry of the lachrymators and pointed out that the reaction with —SH would explain the existence of lachrymatory properties not only in those containing a positive halogen, but also in those containing a $>C=C<$ link, such as acrolein. The same groups (ketone, ester, aldehyde, nitro, etc.) which give the neighbouring halogen its positive properties are known to polarize adjacent olefinic linkages in such a way that they can add nucleophilic reagents, and such substances would be expected to combine with —SH groups thus

$$\begin{array}{lll} \nearrow O \quad \overset{+}{C}H_2 & \ldots & \overset{-}{S}—R \\ \;\;\| \qquad \| & & \\ R'—C—\underset{-}{C}H & \ldots & H^{\cdot} \end{array} \quad \text{giving } R'.CO.CH_2.CH_2.S.R.$$

The carboxyl group, which does not undergo a similar electromeric displacement, is ineffective; though acrylic esters are lachrymators, acrylic acid is not; similarly, iodoacetic acid attacks only a few —SH enzymes and leaves others practically unaffected, while its ester (the lachrymator *K.S.K.*) is a general poison for —SH enzymes.

The site of action of lachrymators was shown to be the corneal nerve-endings[10], and the molar concentration required for stimulation was found to be of the same order as that needed to poison enzymes[11]. So far, however, the nature of the connexion between the —SH groups in the nerve-ending and the production of the nervous impulse is not known, though hypotheses apparently fitting the known facts could be suggested. The work was discontinued for more urgent problems, but further work on these lines may throw light on the mechanism of sensory nerve-endings.

The lachrymators, as was to be expected, were found to be strong inhibitors of cell respiration[2] and glycolysis[17].

Alkyl Fluorophosphonates

These substances, which act as powerful pupil-constrictors or myotics, have recently been described by McCombie and Saunders[12] in *Nature*. It appeared that they might act by inhibiting choline esterase, like other myotics such as eserine, and Dr. Saunders supplied us in 1941 with a series of the compounds for testing. Mackworth[13] and Webb[14] found that they do indeed act as powerful inhibitors of choline esterase *in vitro*. They differ from eserine, however, in that while the inhibition by eserine is not progressive and is easily reversible by dialysis, that due to the fluorophosphonates is progressive and irreversible. The conditions for a standard quantitative manometric test of inhibitory power were worked out, the results of which agreed satisfactorily with the biological tests. The members of the series differ considerably in potency; the most active ones, which also have lethal properties, were found to produce an inhibition even in a concentration of 10^{-11} *M*. These compounds, in fact, are the most powerful and specific enzyme inhibitors known. Apart from the esterases, no enzyme was found to be inhibited at all, even by high concentrations. More recently Webb[15] has found that, in addition to choline esterase, ordinary esterases are inhibited by the fluorophosphonates, although eserine has no action upon them.

Webb[16] also examined the action of the fluoroacetates on enzymes *in vitro*. These compounds are also toxic, but their action seems to have little in common with that of the fluorophosphonates; they do not inhibit choline esterase, or indeed any of the enzymes tested by Webb.

Lewisite

As already mentioned, Peters and his colleagues[18] showed at Oxford in 1940 that arsenicals of the lewisite group strongly inhibit certain —SH enzymes by combining with the —SH groups. They differ fundamentally from the lachrymators, however, in that the combination is reversible, and the degree of inhibition is determined by the affinity of the particular enzyme for the arsenical. There are considerable differences in this respect between the various —SH enzymes, and not all those enzymes which are poisoned by the lachrymators are significantly affected by lewisite[19]. Three enzymes are outstandingly sensitive: a component of the pyruvate oxidase system, which is inhibited 50 per cent by *M*/65,000 lewisite (Peters *et al.*[7]); hexokinase, which (in the absence of its substrate glucose, which has protective action) is inhibited 50 per cent by *M*/100,000 lewisite (Mackworth[19]); succinic dehydrogenase from heart, which Mackworth finds inhibited 100 per cent by *M*/24,000 lewisite, though Peters finds the enzyme from brain comparatively insensitive. Mackworth finds the other —SH enzymes (including triosephosphate dehydrogenase) much less sensitive, requiring concentrations of the order of *M*/1,000, and this was also found by Morgan and Dixon[3] for —SH groups in non-enzymic proteins. Mackworth has suggested that the exceptionally high affinities are due to the presence of the double bond in lewisite ($ClCH{=}CH.AsCl_2$), as they are not found with $ClCH_2.CH_2.AsCl_2$[17,19]. The results depend on the nature of the arsenical; a number have lachrymatory properties, though this is not the case with lewisite, and more comparative studies may identify the enzymes connected with lachrymation more precisely.

The development of the dithiol lewisite antidote *B.A.L.* by Peters at Oxford has already been described in *Nature*[7], where the reversal of pyruvate oxidase poisoning is described. We have found that *B.A.L.* also reverses the lewisite poisoning of hexokinase[5] and succinic dehydrogenase[19]. It is of interest that the poisoning of hexokinase is also reversed (in presence of its substrate glucose) by monothiols such as cysteine[5], which is not the case with the other systems.

B.A.L. has a certain toxicity, and in an attempt to find the cause Webb and van Heyningen[20] in this laboratory studied its action on a large number of enzymes. They found that it is a selective poison for metal enzymes, that is, enzymes the activity of which is due to atoms of copper, iron, zinc, etc., which form part of their structure. Other enzymes were not affected. Thus catechol oxidase (a copper-protein), carbonic anhydrase (a zinc-protein) and peroxidase (an iron-protein) were all inhibited by *B.A.L.* When copper was restored to the inhibited catechol oxidase the original activity was restored. It is clear, therefore, that the inactivation of enzymes by *B.A.L.* is due to its very high affinity for metals, and it may form a useful reagent in testing for metal enzymes. The only enzyme believed to be a metal protein which was not found to be inhibited was cytochrome oxidase, by which, however, the *B.A.L.* was rapidly oxidized.

The development of a non-toxic derivative of *B.A.L.* (*B.A.L.-intrav*) by Danielli and Mitchell in this laboratory in collaboration with Owen and Shaw in the Imperial College[21] has recently been described in *Nature*[22], as has also the preparation of proteins labelled with dye molecules, attached by azo-links, for the study of permeability changes in lewisite shock[23].

Mustard Gas and Related Compounds

A large amount of work was done on mustard gas (*H.*), partly because it was regarded as one of the greatest dangers and partly because the problem proved a particularly difficult one.

H. produces both local and general effects. When a small amount is applied to the skin there is first a delay of about two hours, after which œdema and erythema appear, followed later by vesication. If larger amounts are applied, instead of vesication, necrosis of the skin is produced. In general, vesication is not observed in animals, although their skin shows a well-marked œdema and sometimes erythema. The skin of the perfused frog, however, readily

blisters like human skin, as has been found in this laboratory[24]. *H.* is readily absorbed through the skin into the circulation, and so produces more general systemic effects, especially a degenerative effect on the white cells of the bone marrow and consequent leucopenia, and damage to the gastro-intestinal tract. The effects are likely to prove fatal after a few days if appreciable amounts have been absorbed. There is reason for thinking that the local skin effects and the general systemic effects may be produced by different mechanisms, and they have therefore been considered separately.

(*a*) Local Effects: Biochemistry of Vesication

This problem was approached in 1940 from two different aspects: (*a*) a study of the changes in the metabolism of skin as a result of application of *H.* or similar vesicants; (*b*) a systematic study of the action of *H.* on isolated enzymes *in vitro*. It soon became clear that both lines of work led to the same conclusion, that is to say, the very specific enzyme poisoning by *H.* which was observed *in vitro* would, if it also occurred in the skin, produce exactly those changes in metabolism which were actually found and shown to be correlated with the skin damage resulting from *H.* application.

Metabolism of normal and vesicant-treated skin. Very little was known previously about the enzymes present in normal skin or about its metabolism, and Needham and Dixon[25] therefore first made a study of normal skin. The hairless abdominal skin of rats about four days old was found to be very suitable, being sufficiently thin for manometric experiments without slicing. It was found to have an active metabolism. In bicarbonate-Ringer solution the Q_{O_2} was -5, either in the presence or absence of glucose or pyruvate, and the *R.Q.* was 0·9 with glucose and 0·77 without. The aerobic glycolysis was zero with or without glucose. In anaerobic experiments there was only a little glycolysis without added substrate, but with glucose the $Q_G^{N_2}$ was about 4·5 and with hexosediphosphate about 1·4.

The effect of *H.* application was tested by rubbing it evenly over the under surface of the young rats with a glass rod and keeping them for varying times up to three hours before killing. Untreated rats from the same litter were always used as controls. No immediate metabolic effects were found, but after about two hours signs of skin damage began to appear, becoming marked after three hours, and these were accompanied by two well-marked changes in metabolism. (*a*) There was a sharp fall in the *R.Q.* with glucose from 0·9 to 0·56, although the rate of oxygen uptake remained only slightly below normal. This indicated that carbohydrate could no longer be utilized. (*b*) The anaerobic formation of lactic acid from glucose was strongly inhibited, the inhibition increasing with time, in a manner parallel to the onset of the symptoms, until the glycolysis had fallen to the value obtained without added glucose. (Berenblum[26] had previously reported an inhibition of glycolysis and respiration in tumour tissues.) There was no inhibition of lactic acid formation from hexosediphosphate or from the substrate originally present in the skin.

Much evidence was obtained that a direct connexion exists between this characteristic inhibition of glycolysis and the production of skin damage. Not only *H.* but the other vesicants as well, no matter what their chemical nature, produce the inhibition[17]. Of some twenty-five different vesicants tested, all inhibited the skin glycolysis, except one or two volatile substances which are only vesicant to human skin when evaporation is prevented and which did not damage the rat skin. Some twenty non-vesicant substances, most of them very closely related chemically to the vesicants, did not inhibit and produced no signs of damage. There was a fairly good quantitative correlation between the degree of glycolysis inhibition and the severity of the skin damage, and we never observed damage without inhibition. Moreover, there was also a correspondence in time relations; the inhibition by *H.* only occurs after a delay period, and it is only then that visible damage develops, while with lewisite the inhibition appears almost at once, and so also does the damage.

Further evidence of a connexion with glycolysis is given by the action of prussic acid[24]. Perfusion of the frog with $M/1{,}000$ prussic acid, which inhibits respiration but not glycolysis, produces no vesication. $M/100$ prussic acid, however, inhibits glycolysis, not by poisoning any of the enzymes concerned, but by combining with intermediary metabolites, for example, triosephosphate. Perfusion with this concentration of prussic acid produces copious vesication. It is also of interest in this connexion that Lutwak Mann[27] has found that tissue slices (gastric mucosa) *in vitro* undergo considerable disintegration anaerobically when deprived of glucose, though not in its presence.

The fact that *H.* does not inhibit the glycolysis of hexosediphosphate suggested that it might be the initial phosphorylation of glucose which was inhibited; in other words, that the inhibition of glycolysis was due to the poisoning of hexokinase, the enzyme which catalyses the reaction:

glucose + adenosinetriphosphate = glucose-6-phosphate + adenosinediphosphate.

This could be verified directly[28]. An aqueous extract of ordinary muscle acetone powder contains all the enzymes of the glycolysis system except hexokinase, while hexokinase can be prepared from yeast. A mixture of both preparations therefore gives a complete glycolysis system, converting glucose into lactic acid. This system, like that in skin, is inhibited by treatment with *H.* If the muscle extract is treated with *H.*, and the hexokinase added only after the *H.* has disappeared by hydrolysis, no inhibition is produced. If, however, the hexokinase is treated with *H.*, and the muscle extract added afterwards, a large inhibition results. The effect is therefore a specific one on the initial phosphorylation step.

Further work on skin[29] showed (*a*) that the glycolysis is of the phosphorylating type, as in muscle; (*b*) that hexokinase is in fact present in normal skin, as also in skin a short time after *H.* application; (*c*) that hexokinase is absent from *H.*-treated skin after the inhibition of glycolysis has developed. Several other enzymes were shown not to be inhibited.

Enzymes in vitro. While this work was in progress, a systematic survey of the effect of *H.* on isolated enzymes *in vitro* was undertaken by van Heyningen in this laboratory[30]. Peters[31] had previously shown that the pyruvate oxidase system of brain was inhibited *in vitro* by *H.* sulphone, and a partial

inhibition had also been obtained after stirring brain brei with liquid *H*.[32].

As *H*. reacts with water, in which it is only slightly soluble, the testing of aqueous solutions of enzymes with *H*. presents special problems. The method adopted was to add to the enzyme solution a very small volume of a solution of *H*. in ethyl cellosolve or propyl alcohol and mix rapidly, the amount taken being such as to give $M/400$ *H*. This is sufficiently below the solubility limit at 38° to give instantaneously a clear solution. The solution was then kept at 38° for 20–30 min. before testing the enzyme. Controls were always done with the same amount of solvent (without *H*.), incubated similarly. During the incubation period the *H*. concentration rapidly falls from $M/400$ to practically zero in about 20 min., owing to reaction with water, with buffer salts, and possibly with the enzyme and other components of the system. The mathematical theory of the partition of *H*. by reaction with the various substances in a solution was worked out by Ogston *et al.*[33] at Oxford, and later by Cannan[34] in the United States. The amount of *H*. combining with the different components is determined by their concentrations and their 'competition factors'. The competition factor of a substance is the ratio of the velocity constant of its reaction with *H*. to that of the hydrolysis of *H*. Thus for an enzyme to be sensitive to *H*. under these conditions, the competition factor of its active centres must have a high value.

Van Heyningen[30] found that of about thirty-four enzymes tested, thirty were unaffected by this method of *H*. treatment, so that *H*. is certainly not a general enzyme poison. Later work, mostly in the United States, has added about eighteen further enzymes which are unaffected. Hexokinase, however, was found to be markedly inhibited by *H*. *in vitro*, in agreement with the results of the previous section, and so was the pyruvate oxidase system obtained from *B. coli*[35]. Needham[36] has given reasons for believing that the component of the pyruvate oxidase system which is inhibited may be a phosphate-transferring enzyme belonging to the same group as hexokinase. We suggested the name 'phosphokinase' for this small but important group of enzymes, and both she and Cori[37] in the United States have shown that several (though not all) of the phosphokinases are sensitive to *H*. The evidence for the 'phosphokinase theory' of vesication, according to which vesication results from the poisoning of certain phosphokinases in the skin, was reviewed by Dixon[38] in 1943, and reasons were given for thinking that hexokinase inhibition played the most important part.

In addition to this group there is a second small group of *H*.-sensitive enzymes containing a few proteases, namely, pepsin (Northrop[39]), a tissue peptidase (Bergmann[40]), and a skin proteinase (Peters[41]). Most proteases, however, are insensitive to *H*.

According to Thompson[42], there is a partial inhibition of the choline esterase in skin after *H*. application. As the fluorophosphonates, which are infinitely more powerful inhibitors of this enzyme than *H*., are completely non-vesicant, it is clear that this inhibition cannot be the cause of vesication, although it may contribute to the other effects of *H*. Van Heyningen[30] found no inhibition of this enzyme by *H*. *in vitro*.

A different method of treating enzymes with *H*. has been used especially by Northrop[39] in America, namely, by stirring the aqueous enzyme solution with excess of liquid *H*. The solution is thus kept saturated with *H*., and as the stirring was often continued for several hours, it will be clear that even chemical groups with low competition factors will react with *H*. under such conditions. A fairly general attack on proteins then takes place, and it is not surprising that a fair number of enzymes are affected by this method. It is probable, however, that such conditions correspond rather to the skin necrosis observed with larger amounts of *H*. than to vesication. As vesication is produced by quite small amounts of *H*. we have preferred to keep to our original method.

Hexokinase. (*a*) *Properties.* As it was clear that this enzyme was likely to prove important, and as very little was previously known about it, van Heyningen in 1941 undertook a study of its properties. Working with the enzyme from yeast, she found[5], as shown shortly before by Colowick and Kalckar[6], that it transferred only one of the pyrophosphate groups of *A.T.P.* to glucose, in accordance with the equation given above. Magnesium was necessary for the reaction, but calcium and zinc were inactive. Half the maximum velocity was reached in a glucose concentration of about $M/1{,}000$. The enzyme acted on glucose, fructose or mannose, but little or no activity was found with any other sugar. With excess substrate, the rate with fructose was about twice that with glucose, but the affinity for fructose was only about half of that for glucose, so that in smaller concentrations the rates were approximately equal. Mannose was less active than either.

The enzyme has a broad optimum at *p*H 8–9, but at 38° it is very unstable above *p*H 7. It is stabilized, however, by the addition of its substrate glucose ($M/10$), though not by its other substrate *A.T.P.* or by any of the other sugars, with the exception of mannose. It is also stabilized by muscle powder extract, or by cysteine. It was shown to be an —SH enzyme, readily inactivated by oxidation and reactivated by cysteine, and sensitive (though only in the reduced form) to lachrymators and to the arsenical vesicants, which as already stated combine with the same groups. It seems that most, if not all, of the phosphokinases are —SH enzymes[36].

Hexokinase. (*b*) *Action of vesicants.* We have mentioned above some of the reasons which led us to the hypothesis that hexokinase is the most important point of attack in the skin in vesication by *H*. The strongest evidence, however, came from the action of a large number of vesicants and related non-vesicants on this enzyme *in vitro*. There are special circumstances which are particularly favourable for a definite test of this hypothesis. The vesicants form an extremely heterogeneous group of substances, including the most diverse chemical structures, ranging from *H*. to protoanemonin, from arsenicals to acrolein. Apart from the power of vesication, they seem to have little in common. Nevertheless, if our hypothesis is correct, they should share the property of inhibiting hexokinase. Furthermore, this property should be absent in non-vesicant substances (though an exception is conceivable in the case of a substance which is non-vesicant simply because it cannot penetrate into the skin). This test can be made very stringent, owing to the fact that many substances exist which are very close to *H*. in chemical structure and yet are completely devoid of vesicant properties. This was first pointed out to us by Prof. S. Sugden.

On putting this to the test it was found[17] that there was indeed a most striking correspondence between the occurrence of vesicant properties and power of inhibiting yeast hexokinase *in vitro*. Some fifty substances, about half of them vesicant, were tested. All the vesicants inhibited the enzyme, no matter what their chemical nature; all the related non-vesicants failed to inhibit (with the exception of the sternutator *D.M.*, which cannot penetrate the skin, and one or two alkyl halides which, although strictly non-vesicant, produce œdema and gave a partial inhibition). Some of the results, mostly extracted from the extensive table of Dixon, Needham and van Heyningen[17], are given in the accompanying table.

Substance.	Vesicancy.	% Inhibition of hexokinase *in vitro*.
$S(CH_2CH_2Cl)_2$	++	80
$OS(CH_2CH_2Cl)_2$	—	0
$S(CHCl.CH_3)_2$	—	0
$S(CH_2Cl)_2$	—	0
$S(CH_2CH_2CH_2Cl)_2$	—	0
$O_2S(CH=CH_2)_2$	+	60
$OS(CH=CH_2)_2$	—	0
$S(CH_2CH_2OH)_2$	—	0
$C_2H_5.S.CH_2CH_2Cl$	+	45
$C_6H_5.S.CH_2CH_2Cl$	+*	40
$CH_3N(CH_2CH_2Cl)_2$	+	65
$N(CH_2CH_2Cl)_3$	+	70
$ClCH=CHAsCl_2$	++	100
$ClCH_2CH_2AsCl_2$	—	0
$CH_3CH_2AsCl_2$	+	45
C_2H_5I	—	30
CH_3Br	++*	90
BAL	—	0
FCH_2COOCH_3	—	0
$(C_3H_7)_2FPO_3$	—	0
$CH_2=C.O.CO$ / $CH=CH$ (ring)	+*	40

* When evaporation is prevented.

The results of these tests afford strong circumstantial evidence of the truth of our hypothesis. Up to the present, hexokinase remains the only cell-constituent which has been found to pass the test.

The enzyme tests *in vitro* actually led to the discovery of vesicant properties in several compounds which were not known previously to possess them. A few substances, submitted to us as non-vesicants, were found to inhibit the enzyme (for example, $C_6H_5.S.C_2H_4Cl$). Further examination showed[17] that the apparent lack of vesicancy was due to rapid evaporation from the skin; if this were prevented by covering with a glass cover-slip, good vesication was obtained. Furthermore, it was predicted from the fact that hexokinase was an —SH enzyme, inhibited by lachrymators, that lachrymators should also be vesicants. This was already known in certain cases, but we verified the prediction with all the available lachrymators, when evaporation from the skin was prevented.

The tests showed a further point of some interest. The presence of glucose protects the enzyme to some extent against poisons, presumably by covering the active centres—a fairly common effect with enzyme substrates. We found that with high concentrations of glucose a few vesicants failed to inhibit the enzyme. With no glucose at all, on the other hand, it became very sensitive to vesicants, but was also inhibited by many of the non-vesicants. A proper correlation was only obtained in the presence of the physiological glucose concentration, such as would actually be present in the tissues *in vivo*.

In contrast to the lachrymators, *H.* attacks both oxidized and reduced forms of the enzyme; moreover, while lewisite protects the enzyme against lachrymators by masking the —SH groups, it does not protect against *H.*[5]. It is therefore improbable that the poisoning by *H.* is due to an attack on —SH groups. This is in agreement with observations by Peters and ourselves that the reaction of *H.* with —SH groups in proteins is very slow in comparison with the reaction of lachrymators with these groups.

Crystalline hexokinase. In order to study the chemical nature of the reaction of *H.* with the enzyme, it was necessary to have the latter in the pure state. A method of isolation from yeast was worked out in this laboratory by Bailey and Webb[43], the final crystallization step being the same as in the method of Northrop[44], which had been reported a short time before. The crystals were identical in every way with those of Northrop.

As the amount of recrystallized enzyme available was small, it was not practicable to estimate the amount of *H.* combining by S analyses as usual. In collaboration with members of Prof. Wormall's team, therefore, the enzyme was treated, under the same mild conditions as in our previous *in vitro* work, with *H.* containing radioactive sulphur (*H.**). The extent of the inhibition was determined, and the treated enzyme was precipitated with alcohol, exhaustively extracted with alcohol, acetone and ether, dried, and the N and S* determined by the usual methods. From the results it was calculated that when there was 100 per cent inactivation by *H.*, each molecule of hexokinase (mol. wt. 97,000) had combined with 6–7 *H.* molecules. This means that the combination of less than 1 in every 100 amino-acid residues in the enzyme with *H.* is needed to effect complete inactivation; this is consistent with the view that the attack is a specific one on the active centres, and it is certainly not a general one on the enzyme protein.

The nature of the groups attacked in the enzyme is not known. Their competition factor is high (about 8,000) in the absence of glucose; in $M/150$ glucose it is reduced to about 800. A number of attempts were made to reverse the combination with *H.* and so restore the enzyme activity, but without success.

For comparison with hexokinase, the combination of *H.** with ovalbumin, fibrinogen and serum proteins under the same mild conditions of treatment was determined, in order to see whether the *H.*-sensitive groups were peculiar to hexokinase. It was found[43] that the amount of *H.* combining was of the same order in all four cases. The conclusion drawn was that although hexokinase is exceptionally *H.*-sensitive as an enzyme, it is not so when considered as a protein; in other words, its sensitivity is not due to any special reactivity to *H.*, but to the fact that in this particular enzyme the activity depends on the groups which react with *H.*, which is evidently not the case with most other enzymes. Presumably it is only when the combination of an enzyme with *H.* affects its activity that metabolic disturbances and consequent tissue damage can result.

(*b*) General and Systemic Effects

When the importance of the systemic effects of *H.* became clear, we turned our attention to the biochemical mechanisms underlying them. It could not be assumed that they were the same as that underlying vesication. Special attention was given to the tissues most affected, namely, the bone marrow and the gastro-intestinal tract.

Bone marrow. Needham, Cohen and Barrett[45] studied the metabolism of marrow, both in its normal

state and after the injection of a lethal dose of *H*. They found a very marked fall in anaerobic glycolysis, which was just perceptible after four hours and complete after twenty-four hours, running parallel with or slightly preceding the cell damage observed histologically. It was not shown, however, that this was due to a poisoning of hexokinase. In marrow, unlike skin, the whole metabolism, including the respiration, falls after *H*., and the effect is not a specific one on one reaction only.

H. was found to inhibit marrow glycolysis immediately *in vitro*, and it is possible that this was due to a poisoning of hexokinase. It seems from the work of Cori[46] that phosphokinases are inhibited in several different tissues after treatment *in vitro* with *H*. and similar compounds, but that they are not inhibited in the same tissues in systemic poisoning, although other enzymes (for example, pyrophosphatase, choline oxidase, choline esterase) may be.

Gastro-intestinal tract. Greville and Barrett[47] examined the metabolic changes in the intestinal mucosa side by side with the histological changes after *H*. injection and found a definite fall in glycolysis running fairly parallel with the damage. It seems, however, that this was due to the fact that the rats ceased to eat during systemic poisoning, and not to hexokinase inhibition. The glycolysis in this tissue depends very much on whether the animal has been recently fed, and equally large differences were found between normal fed and fasting rats. Cori has in fact shown that hexokinase is not inhibited in this tissue in systemic *H*. poisoning.

Lutwak Mann[47a] at the same time examined the metabolism of gastric mucosa and found a similar fall in glycolysis in the badly affected rats, and a rise again in those which spontaneously recovered, though it is not yet certain how far these results were due to the fasting. *H*. strongly inhibited the glycolysis *in vitro*, as in other tissues.

Fate of injected H. *in the body*. In connexion with the systemic effects it is of interest to know the distribution of injected *H*. in the body, and in particular where most of the *H*. reacts. When *H*. combines with a cell-constituent, for example, a protein, it is no longer extractable with organic solvents, and is said to be fixed. This problem was studied in collaboration with members of Prof. Wormall's team[48], who had prepared *H*. containing radioactive sulphur for this purpose[49]. This was injected intravenously into rabbits, and the amounts of fixed and total S* (radioactive sulphur) in the different tissues determined after varying times. S* appeared within a few minutes in the urine and bile, but although notable amounts were excreted in this way, the greater part was found in the tissues, and of this most was in the fixed form. There were large differences between the different tissues; very large amounts of *H*. were fixed in kidney (peak value at one hour) and lung (peak at four hours) compared with other tissues; bone marrow was at the other extreme with a content only about 1/20th of the maximum in kidney and lung. It is surprising that marrow, the tissue most damaged, had the lowest *H*. content, while the two tissues with by far the highest *H*. content are practically undamaged by *H*. poisoning. Another surprising feature was that almost all the fixed *H*. had disappeared from the tissues after twelve hours, which would not be anticipated if the *H*. were fixed to cell protein.

H. sulphoxide. In this substance (*HO*), unlike *H*., the Cl atoms are unreactive, it does not hydrolyse in water, is non-vesicant, has no effect on the enzymes tested or on tissue metabolism *in vitro*[47,47a], and even in high concentration does not combine with proteins[43]. Yet according to Marshall and Williams[50] it is as toxic as *H*. by injection. Radioactive *HO* was therefore prepared and injected, in the expectation that systemic effects similar to those of *H*. might be produced without fixation of S* in the tissues[51]. The surprising result was that not only was even more S* fixed in the tissues with *HO* than with the same dose of *H*., but that the rabbits suffered absolutely no ill effects or histological damage[47,47a]. With much larger doses of *HO*, systemic effects like those of *H*. were produced, with damage to the marrow and digestive tract. It is possible, of course, that *HO* may be converted in the body into some more reactive substance; the closely similar distribution to that of injected *H*. strongly suggests that the same kind of reaction, and perhaps the same substance, is responsible for the fixation of both. Nevertheless, with *HO* no damage is produced (for example, in the marrow) by an amount of fixation which, in the case of *H*., wrecks the tissue. This leads to the conclusion that the chemical groups blocked are not essential to the cells; in other words, that the fixation is not in the main due to the reaction which causes the damage.

This leads to the following hypothesis, which accounts for many of the facts. Assume that the damage results from the poisoning of an essential tissue constituent *E*. (hexokinase or some other substance); the tissues also contain varying amounts of another substance *N*. (not necessarily a protein) which is non-essential, but which has a higher competition factor than *E*. Then in those tissues which contain much *N*. much *H*. will be fixed, but at the same time the *H*. will be diverted from *E*., which will therefore be protected. A tissue which contains only a little *N*. (marrow) will fix little *H*., but will be severely damaged because the *H*. can immediately attack the *E*. This may also explain the puzzling delay in the action of *H*. on skin, for the *H*. will react first with the *N*., and it is only when all the *N*. is used up that it will attack the *E*. appreciably. In marrow *in vitro* there is practically no delay in the action of *H*.

The work on *H*. is still incomplete, but was terminated when it became clear that there was no likelihood of gas warfare.

Natural Vesicants of Plants

The juices of certain crushed plants have vesicant properties. At the suggestion of Porton these were investigated by Hill and van Heyningen[52]. In the case of the buttercup they isolated the naturally occurring substance in pure crystalline form and identified it as a glucoside, which forms a surprisingly large fraction of the total carbohydrate of the plant. The glucoside itself is harmless, but is hydrolysed by an enzyme which is liberated when the plant is crushed, and it then yields free proto-anemonin

$$\begin{array}{l}(CH_2{=}\overset{}{C}\,.\,O\,.\,CO) \\ \qquad\;| \qquad\quad | \\ \qquad CH{=}CH\end{array},$$

which is the vesicant. It evaporates fairly readily from the skin, but when this is prevented it is a fairly powerful vesicant.

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A reference thus "Dixon Report No. 10 (1941)" denotes a report submitted to, and given a restricted circulation by, the Chemical Defence Research Department of the Ministry of Supply in that year. "Biochemical S.C. Minutes. 28.11.41" denotes the circulated minutes of the meeting of the Biochemical Sub-Committee of the Chemical Board of the Ministry of Supply, held on November 28, 1941.

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LONDON TRAFFIC AND THE LONDON PLAN

The problems of London traffic become more acute with every week that passes, and it is generally accepted that no schemes for reconstructing and replanning London will be satisfactory without drastic adjustments to existing facilities for transport. At a conference held at the Institution of Civil Engineers on September 12–13, on "London Traffic and the London Plan", the British Association provided a platform for the discussion of some of the problems involved in planning large-scale improvements which will not merely prevent London's traffic from seizing up in the near future but also will serve the requirements of future generations.

The conference, which was opened by Sir Richard Gregory, president of the Association, was held in three sessions. At the first, over which Lord Latham, leader of the London County Council, presided, there were general papers on traffic, town planning and architecture; at the second, more technical papers on roads, railways, underground railways, air transport and sub-surface works; and at the third, open discussion. Sir William Halcrow, president of the Engineering Section of the Association and president-elect of the Institution of Civil Engineers, took the chair at the second and third sessions.

The principal plans for reconstructing London are the L.C.C. (1943) Plan, the Greater London (1944) Plan, and the City of London (1946) Plan, and these, together with the Highway Development Survey (1937), the 1946 report to the Minister of War Transport by the Railway (London Plan) Committee, formed the background of the papers and discussion.

In opening the conference, Sir Richard Gregory referred to the magnitude of the task confronting those who were responsible for taking decisions on the replanning of London and of carrying them out. Many questions must be put and answered before the real work could begin in the right order and on the right scale. Men of science could contribute to this vast enterprise and should be consulted to the full; apart from the giving of technical advice there was, here, a great opportunity for the application of the scientific discipline of experiment and research, critical examination of evidence, and finally drawing up conclusions and objectives.

Lord Latham said that the L.C.C. had accepted the proposition that one of the major defects of London was an obsolete road system, and would do all within its power to effect improvements. London must be replanned while the life and activities of its millions went on, and these could neither be stopped nor even greatly slowed down, nor could any responsible authority contemplate, in the present shortage of housing, any substantial destruction of living or business accommodation to make way for new roads. This was, however, no apology for complacency. He announced that the L.C.C. had settled in principle a short-term programme of post-war work on roads in the County, and was at work on a second programme to be carried out over a longer period. The cost of all the schemes under consideration might be put tentatively at £100,000,000; the short-term programme was estimated at £20,000,000, and those parts of it which had been passed for execution in the initial period would cost £8,000,000. The L.C.C. would welcome any guidance or counsel which the Conference could give.

Sir William Halcrow said that, so far as road traffic was concerned, it seemed to him that more road space was essential, and this raised the question whether new roads or the crossings should be above, below or at the level of existing roads. The advantages and disadvantages of each needed discussion; but in view of the congestion of existing underground services of all kinds, the balance appeared to be in favour of overhead construction, which had been achieved with success in Sweden and had been recommended by road planners in Great Britain so long ago as 1904. As regards railways, most of the main-line London termini were about a hundred years old and needed rebuilding. Recent proposals that some should be put underground raised engineering problems which would need serious examination; other proposals envisaged a closer grouping of these termini, but it should be considered whether this would not add to congestion on roads in the immediate vicinity.

Sir Alker Tripp, assistant commissioner of Metropolitan Police, said that the change from horse-drawn to motor traffic had been revolutionary, and nothing short of a revolution in the design and use of roads would be sufficient to remedy the defects of the present system. Redesign of existing roads and the planning of new roads must serve two purposes, circulation and safety. As regards circulation, there were lessons to be learnt from the railways, which could not operate without sidings; and the first remedy was to provide adequate car parks, underground, at ground-level, and in multi-storied buildings. As regards safety, there was wide scope for improvements. There were two million casualties on the roads of Britain in 10 years before the War, and in London 60 per cent of the killed were pedestrians; the daily toll of life continued at a dreadful level, although there was less traffic on the roads. He was convinced that the main expedient for stopping wanton exposure of pedestrians to fast traffic was to divert the main stream of traffic flow from the daily haunts of the people. Planning should distinguish between roads built as traffic conduits and those intended for shopping and local services. Existing roads should be reclassified and the design of new roads should not be attempted before their purpose was clearly determined.

Prof. W. G. Holford, joint author of the City of London Plan, maintained that amenity, hygiene, scenic effect, traffic flow and safety should not be overstressed as the dominant considerations in planning traffic facilities: they all ultimately depended on the economic function of the area to be served. Compromise would no doubt be necessary; but clear objectives should first be decided. Dealing with private cars, he recalled that in 1938 they were increasing at the rate of a thousand a day. As the number on the roads at the present time was about the same as in 1939 (3,189,000), and as this number could be expected to increase, it was not impossible that there would be a doubling of the load within the next thirty years. Urban development and satellite towns would reduce the number of journeys to and from large cities; but the gain might be offset by increased travelling resulting from rising standards of life. Reviewing the probable cost of adequate improvements in all forms of transport, Prof. Holford submitted that, in many cases, such development was beyond the resources of local authorities and that the financial burden might have to be borne regionally, if not nationally. He saw the replanning of London as a vast combined operation, involving the co-ordination of land use, architecture, administration, research and execution, and presented a number of broad conclusions coupled with suggestions for priority of work and for immediate research.

The concluding paper of the first session was read by Mr. W. H. Ansell, past-president of the Royal Institute of British Architects, who asked that roads should not be regarded, as was too often the case, as traffic conduits along which it was permitted to place buildings. Just as buildings were planned so that corridors did not occupy space at the expense of rooms, so towns should be planned so that roads did not unduly cramp the buildings between them. Furthermore, before existing roads were widened or new roads were built, there should be a scientific examination of the nature and volume of the traffic likely to use such roads, having regard, among other things, to the probable difference in traffic loads which would result from the removal of badly sited industry or railway termini or markets such as Billingsgate and Covent Garden. The average man was hoping that there would be substituted for ugliness, slums and smoke, the beauty of a spacious orderliness of which war has so often deprived him, and although there were dangers in planning for architectural effect, appearance should not be overlooked. In his view the scale and size of buildings could with advantage be increased; both traffic and architecture would benefit from a pooling of sites, and congestion on roads could be relieved by providing parking and loading facilities within the perimeter of buildings.

The first paper of the second session was read by Mr. A. J. Lyddon, lately chief engineer of the Roads Division, Ministry of War Transport, who dealt with roads. Using the example of Western Avenue which, though only ten miles long, took twenty years to complete, he enumerated some of the difficulties such as public inquiries, land acquisition, legal proceedings, and so on, which tended to delay physical construction and which must be taken into account in setting targets for the next few years. Referring to the L.C.C. (1943) Plan, which assumed that congestion in central London is largely due to through traffic, which ring roads would obviate, he advocated, as did a number of other speakers, a systematic census which would indicate the origin, destination and nature of London's traffic. Such a census would be costly and would take time, but it appeared to be a prerequisite of intelligent planning.

Mr. V. A. M. Robertson, chief civil engineer of the Southern Railway, spoke with special reference to railways. As an example of the difficulties which would face engineers if railway termini were to be put underground, he analysed the requirements at Charing Cross, and came to the conclusion that, assuming the diversion of all main-line traffic to other stations, suburban traffic alone would need an underground station costing perhaps £17,000,000 and involving the use of escalators deeper than any existing to-day. In general comment, Mr. Robertson made the following suggestions: bridges, viaducts and stations should not be moved, and no decision to move them should be taken until adequate underground substitutes were guaranteed; all railways within the Greater London area should be electrified, engines being changed if need be, as in the United States, outside the County boundary; suburban traffic should be separated from main-line traffic so far as possible; express underground lines should be provided wherever demand required; main-line

terminals should be connected by convenient underground lines; all goods depots should be removed to carefully selected centres served by roads restricted to commercial vehicles at certain times; horse-drawn traffic should be banned from heavily used roads; hours of work should be staggered; above all, a prompt start should be made on the vast amount of investigation and design which was needed.

Mr. E. Colston Shepherd, secretary-general of the Air League of the British Empire, presented a paper on air transport which, in his absence, was read by Wing-Commander T. R. Cave-Browne-Cave. He discussed the trend of the load passing through Heathrow and Northolt, and the expectation concerning European services alone was that there would be a traffic between them, taken together, and London of 6,000 persons per day in 1948 rising to 8,000 per day in 1951. Discounting helicopters as offering no immediate substantial relief, the choice of transport to and from the airports lay between roads and railways. As there was little evidence that the western approaches to London would be rapidly improved, the balance was in favour of railway transport, and, further, adjustment to underground facilities leading to Earl's Court appeared to be relatively more simple than adjustment of main-line tracks. This conclusion led Mr. Shepherd to advocate that the Government should reconsider a decision to reserve for trade exhibitions the buildings at Earl's Court, which were considered to be admirably suited for a central terminus for air traffic.

In a paper on sub-surface works, Mr. H. F. Cronin, chief engineer of the Metropolitan Water Board, described the congestion of existing underground services for supplying water, gas, electricity, telephones, and so on, all of which must be taken into account not only by those who would solve overhead congestion by going underground, but also by any who planned diversion of existing streets or the sinking or raising of their level. Removal of these services was both costly and slow, and he thought that the proposals in the various London Plans should be considered from this angle. He supported the proposal that a committee of engineers might well be appointed to examine and report on the engineering implications of the London Plan.

The second session concluded with a paper by Mr. J. C. Martin of the London Passenger Transport Board, who dealt with underground railways and who, in the light of very long experience in the construction of the present underground system, analysed the engineering implications of proposals that underground tunnels and stations should be constructed for main-line rolling stock and traffic. He was inclined to believe that much could be done without drastic modification of existing services to improve the present facilities, and strongly supported the proposal that a co-ordinating technical body should be appointed to work continuously on the problem.

The third session was devoted to free discussion, which was opened in a lively and provocative manner by Colonel Mervyn O'Gorman, and continued by many other speakers, including Dr. R. V. Southwell, Sir Frederick Cook, Prof. Cave-Browne-Cave and Mr. J. S. Wilson.

The full proceedings will be published in the *Advancement of Science*, and in the meantime the report of the Conference will be studied by officers of the Engineering Section with the view of deciding on what points further action should be recommended.

D. N. Lowe

ROYAL PHOTOGRAPHIC SOCIETY EXHIBITION

THE ninety-first Exhibition of the Royal Photographic Society was opened on September 14 by Sir Henry Dale. This exhibition, which is open to the public, can be regarded as the first fully post-war exhibition of the Society, and a great effort has been made to make it an outstanding occasion, to compensate for the previous six lean years during which time acute shortage of photographic materials and security measures had a marked effect on the quantity and quality of the exhibits. Contrary to the usual practice the exhibition is being held in a gallery of the Science Museum, Exhibition Road, London, S.W.7, where there is much more accommodation than is available at the Society's house in Prince's Gate. A special effort has been made to obtain more material, particularly in the Scientific and Technical Section, and some of the research carried out during the War and held up for security reasons has been released. This section is undoubtedly of a higher standard and contains more material than has ever before been shown in the Society's exhibition. The organisers as well as the exhibitors are to be congratulated on the result, which is well worth a visit. The exhibition is open on Monday to Friday 10 a.m.–8 p.m., Saturday 10 a.m.–6 p.m., Sunday 2.30 p.m.–6 p.m., until October 26.

In a short space it is not possible to mention all the exhibits of scientific interest, and it is difficult to make a selection because of the great variety of different subjects illustrated. There are, however, a number of exhibits which will attract special attention either because they illustrate relatively recent developments in which photography has played an important part, or because of the striking nature of the illustrations of quite well-known techniques. In the first category may be placed a number of electron micrographs. One from the Kodak Laboratories is of particular interest to photographers as it shows the filaments of silver produced by development of silver grains in photographic emulsions. A later technique is beautifully illustrated by the exhibit from the Department of Biomolecular Structure of the University of Leeds. The technique was developed by Williams and Wyckoff and consists in projecting a beam of atomic gold at a very small angle towards the plane of the thin collodion membrane supporting the specimen. The film and specimen become coated with a thin film of gold except for the 'shadow' portions protected by the raised parts of the specimen. Gold, being a dense metal, gives a contrasty record when examined in the electron microscope, and the resultant picture has more the appearance of a normal photograph showing modelling than a conventional electron micrograph. Bacilli and the tobacco mosaic virus are among the examples; the magnification in the electron microscope is in all cases 9,500 times, and the enlargements bring the overall magnification up to as much as 57,000 times.

An exhibit of topical as well as scientific interest is that shown by Dr. C. F. Powell and others from the H. H. Wills Physical Laboratory, University of Bristol. This illustrates, by means of many prints, the use of the photographic technique of recording the tracks of fast-moving charged atomic particles. When a charged atomic particle traverses a photographic emulsion, it renders at least some of the silver

halide grains through which it passes developable. The quality of the resulting track depends upon the nature of the particle and upon the characteristics of the particular photographic emulsion used. All the photographs in this exhibit were made from tracks obtained in Nuclear Research Plates specially made for use with this technique by Ilford, Ltd. The exhibit contains examples of records of alpha particles, protons, tritons, and the products of disintegration and fission. Neutrons cannot, of course, be recorded by this means because of the absence of charge, but protons ejected by neutron bombardment provide enlarged tracks some 3 ft. long (1·4 mm. actual). Alpha-particle tracks are produced both by bombarding the plate at grazing incidence with alpha-particles from polonium, and by bathing the plate in a solution of a thorium compound. Alpha-particle and triton tracks are produced by disintegration of lithium atoms incorporated in the emulsion during manufacture and bombarded with 9 MeV. neutrons. Uranium fission tracks are produced by bathing and bombarding with slow neutrons. The photographs are accompanied by adequate captions, and the whole exhibit is covered by an excellent descriptive folder attached to the case.

The exhibit of Mlle. Y. Cauchois from the Laboratoire de Chemie Physique, Paris, illustrates a new technique in the production of X-ray spectra. A crystal is bent into the arc of a cylinder and acts towards X-rays in the manner of a cylindrical lens. This provides the possibility of focusing a beam of X-rays, and the technique is illustrated with X-ray emission and absorption spectra and X-ray shadowgraphs of small objects irradiated by X-rays and 'imaged' on a photographic material by means of such a 'lens'.

The Kodak Laboratories show a picture of molecules of hexamethyl benzene and phthalocyanine by an X-ray diffraction method at a magnification of 250 million. The details of the method used are not specified; but the groups of which the molecules are composed are shown as diffuse dark areas in a clear ground.

In the X-ray field must be mentioned the exhibit by J. A. Fairfax Fozzard, which has been awarded the Rodman Medal. This illustrates, by means of a series of X-ray studies, the shell deposition in the egg of the domestic fowl. Radiographs have been made at intervals during the period of about twenty-six hours between the laying of one egg and the next. The shell of the egg has a greater opacity to X-rays than the surroundings, particularly around the circumference where the distance traversed through the shell material is greatest, so that the boundary of the egg is clearly seen.

High-speed photography is nearly always represented in the Exhibition, and this year there are several particularly interesting examples. The National Physical Laboratory shows a shadowgraph of a modern wing section in a 650 m.p.h. air stream at an exposure of one microsecond; also a series of shadowgraphs of a projectile in flight at different velocities. The latter shows the variation of wave pattern with velocity, from 0·86 to 2·51 times the velocity of sound, in five stages. There are two interesting high-speed radiographs shown by the Research Laboratories of the Westinghouse Electric Corporation. One shows a 20-mm. shell and the other a model bomb both just after bursting. The distribution pattern of the fragments is clearly shown.

Some of the research in air photography carried out during the War is illustrated by a number of exhibits from the Royal Aircraft Establishment, Farnborough. The value of movement compensation in night photography is illustrated. The film is moved in the focal plane at a rate based upon the speed and altitude of the aircraft, so that the image remains substantially stationary during exposure. This technique is particularly valuable for night photography since it permits longer exposures. The same principle is used in very low-altitude air photography in daylight, when the image movement is so great that exceedingly short exposures would be required to give sharp pictures. In the exhibits shown the image moves over a slit in the focal plane and the film is moved at the appropriate speed behind the slit. No camera shutter is required.

These are but few of the one hundred and sixty-four exhibits in the Scientific Section. The Natural History Section contains more than one hundred and fifty prints, and for relaxation there are some two hundred prints in the Pictorial Section, also lantern slides and stereoscopic photographs, etc. There is no doubt that this is the finest exhibition the Royal Photographic Society has organised, at least for many years. It is partly due to the increased space available, to the release of material after the War, and to the convenience of the lay-out which has been made possible by holding it in a gallery of the Science Museum.

During the period of the Exhibition there are six lectures and film shows open to the public. Admission to these is free but by ticket only. Particulars and tickets may be obtained from the secretary of the Royal Photographic Society, 16 Prince's Gate, London, S.W.7.

OBITUARIES

Dr. William Payman

William Payman, a principal scientific officer of the Safety in Mines Research Board and known at home and abroad for his researches on flame and explosives, died on August 10 at the age of fifty after a short illness. He leaves a widow and two sons.

After graduating at the Manchester College of Technology in 1915, Payman began a post-graduate study of the inflammation of gas mixtures under the guidance of Dr. H. F. Coward, with whom he was again to become associated in later years. He pursued this field when in 1917 he joined the staff of the Home Office Experimental Station at Eskmeals, Cumberland, an organisation devoted to an examination of the explosion hazards in coal mines and later expanding into the Safety in Mines Research Board, with stations at Buxton and Sheffield. During his early years at Eskmeals, Payman developed rapidly under the stimulating direction of the late Prof. R. V. Wheeler, and here was formed the nucleus of what was to become the Sheffield school of flame research when Wheeler became also professor of fuel technology at Sheffield. Payman's contributions are recorded in numerous papers in the *Journal of the Chemical Society*, notably in the years 1919–22, and he formulated his 'law of flame speeds in mixed gases', the cause of a sharp controversy with the school which had grown up under the late Prof. W. A. Bone at the Imperial College.

Although he always retained his active interest in flame, Payman transferred his attention in the early 'twenties to a more pressing problem, one aimed at ensuring the safe use of explosives in coal mines. Little was known regarding the intrinsic safety of the 'permitted' class of explosives when fired in contact with firedamp, nor of the means whereby gaseous mixtures were ignited by explosives, whether by contact with flame, hot gases or incandescent projected particles or by adiabatic compression in the shock wave. He set out with characteristic vigour and determination to study these possibilities, while at the same time approaching the problem more directly from its practical aspects. In this work he was aided by a team of research workers whom he imbued with his own enthusiasm and whose judgment and ideas he valued. These researches are described in the *Proceedings of the Royal Society*, in papers of the Safety in Mines Research Board, and in various mining journals. Payman's individual and original researches were recognized by the award of the D.Sc. degree by the University of Manchester in 1929.

Payman believed strongly in the value of fundamental research in the study of practical problems. His resuscitation and development of *Schlieren* photography due originally to Töpler were mainly responsible for its extensive modern usage, and many of the photographic techniques developed by Payman and his co-workers have been duplicated in other countries. Much of the mining research carried out by Payman and his co-workers was interrupted in 1939 and remains unpublished; even so, he contributed more than sixty papers to the scientific and technical press. He was also joint author with Prof. I. C. F. Statham of a monograph on "Mine Atmospheres". He achieved international recognition in 1938 when he was appointed president of the Explosives Section of the Congress of Applied Chemistry held at Nancy. He was also for some years secretary of the informal Explosives in Mines Research Committee of the Safety in Mines Research Board.

It seemed fitting that the main effort of the explosives section of the Board's staff should be diverted during 1939–45 to war-time problems, and it was here that Payman was at his best, directing with unflagging energy a variety of researches connected with the Service use of explosives, and serving on committees of the Ministry of Home Security and of the Scientific Advisory Council of the Ministry of Supply. It is too soon to write in detail of this contribution to the national effort and much will inevitably remain unpublished; it is sufficient to say that Payman derived an intense personal satisfaction from his efforts and those of his staff, from whom he received loyal support. The end of the War found Payman replanning for the Safety in Mines Research Board the organisation of his section to cope with a full renewal of its peace-time function in addition to a continuation of some of the war-time researches; these plans were coming to fruition when illness intervened.

Despite his aptitude for experiment, Payman gained greater satisfaction from co-ordinating and guiding the researches under his control; he had the rare ability of controlling without interfering, and his quiet manner quickly won him the confidence of those with whom he dealt. This was evident both in technical committee and during talks with the many large parties of miners, sometimes sceptical of the experiments they were witnessing, who visited the research station at Buxton. It may truly be said of Payman that his work was his life. His confidence and his friendship, not lightly given, were valued highly by his friends and colleagues, many of whom were associated with him during more than twenty-five years of joint effort to achieve safety in mines.

F. V. Tideswell

We regret to announce the following deaths:

Prof. M. Camis, formerly professor of physiology in the Universities of Parma and Bologna, on August 28, aged sixty-eight.

Mr. H. J. E. Peake, president during 1926–28 of the Royal Anthropological Institute, on September 22, aged seventy-eight.

Dr. Hassan Suhrawardy, during 1939–44 adviser to the Secretary of State for India, formerly vice-chancellor and dean of the Faculty of Medicine of the University of Calcutta, on September 18, aged sixty-one.

Mr. George Tickner, an authority on British birds, aged seventy-eight.

NEWS and VIEWS

Atomic Scientists' Association: International Contacts

The desirability of setting up an international federation of atomic scientists was discussed at the conference held by the Atomic Scientists' Association at Oxford during July, at which foreign men of science were present. Because of the diverse forms in which atomic scientists were or might be organised in different countries, and of the difficulties of getting one central body to speak on behalf of scientific men scattered over the world, it was decided that it was not warranted at present. The need for international contacts, however, was stressed, and one man of science from each of the foreign countries represented (France, Holland, India, Norway, Sweden, Switzerland and the United States) volunteered in a personal capacity to be responsible for liaison and for the exchange of published literature between the Atomic Scientists' Association and any bodies already existing or which might be set up with similar aims in their own countries. To extend this, a letter setting out the aims of the Association—"To maintain in Great Britain an informed public opinion about atomic energy, in order that all possible steps shall be taken to secure, in the words of the Washington Declaration of November 1945, international control to the extent necessary to insure its use only for peaceful purposes"—was afterwards sent to the academies of science and various scientific men in countries not represented at the conference, with a request that it might be brought to the notice of the scientific workers of their country and, if possible, a correspondent be appointed with whom the Atomic Scientists' Association can keep touch. The countries circularized were the Argentine, Australia, Belgium, Brazil, Canada, China, Czechoslovakia, Denmark, Jugoslavia, New Zealand, Poland, South Africa and the U.S.S.R.

RECENT SCIENTIFIC and TECHNICAL BOOKS

Volumes marked with an asterisk (*) have been received at "NATURE" Office

Mathematics: Mechanics: Physics

BRODIE, M. E. Mathematical Examples. Cr. 8vo. Pp. 50. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1946.) 10*d.*

COLUMBIA UNIVERSITY (STATISTICAL RESEARCH GROUP). Sequential Analysis of Statistical Data: Applications. Prepared for the Applied Mathematics Panel, National Defense Research Committee, Office of Scientific Research and Development. (SRG Report 255.) Demy 4to. Pp. xxix +287. (New York: Columbia University Press; London: Oxford University Press, 1945.) 42*s.* net.*

FLETCHER, A., MILLER, J. C. P., and ROSENHEAD, L. An Index of Mathematical Tables. Roy. 8vo. Pp. viii +451. (London: Scientific Computing Service, Ltd., 1946.) 75*s.**

JOSEPHS, H. J. Heaviside's Electric Circuit Theory. (Methuen's Monographs on Physical Subjects.) Fcap. 8vo. Pp. viii +116. (London: Methuen and Co., Ltd., 1946.) 4*s.* 6*d.* net.*

MATHIEU, JEAN-PAUL. Spectres de vibration et symétrie des molécules et des cristaux. Roy. 8vo. Pp. iii +496. (Paris: Hermann et Cie., 1945.)*

RAMSEY, A. S. Hydrostatics: a Textbook for the use of First Year Students at the Universities and for the Higher Divisions in Schools. Second edition. Demy 8vo. Pp. viii +170. (Cambridge: At the University Press, 1946.) 8*s.* 6*d.* net.

REYNOLDS, T. J. Building Mechanics. (Junior Technical Series.) Demy 8vo. Pp. 230. (London: English Universities Press, Ltd., 1946.) 6*s.* 6*d.* net.

SIMMONS, HARVEY ALEXANDER. Plane and Spherical Trigonometry. Second edition. Demy 8vo. Pp. xi +387. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1946.) 13*s.* 6*d.* net.

Engineering

BALLIN, H. H. The Organisation of Electricity Supply in Great Britain. Demy 8vo. Pp. xv+323. (London: Electrical Press, Ltd., 1946.) 21*s.* net.*

BRAYMER, D., and ROE, A. C. Repair Shop Diagrams. Revised edition. Cr. 8vo. Pp. 388. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 21*s.*

CHATFIELD, H. W., and WREDDEN, J. H. Varnished Cloths for Electrical Insulation. Demy 8vo. Pp. x +255 +16 plates. (London: J. and A. Churchill, Ltd., 1946.) 21*s.**

CORNELL, R. K. Heating and Ventilating for Architects and Builders. Cr. 4to. Pp. 56. (London: Paul Elek (Publishers), Ltd., 1946.) 7*s.* 6*d.* net.

COTTON, H. Electric Discharge Lamps. (Monographs on Electrical Engineering, Vol. 12.) Demy 8vo. Pp. xvi +435. (London: Chapman and Hall, Ltd., 1946.) 36*s.* net.*

DUBOIS, J., and PRIBBLE, A. Plastics Mold Engineering. Demy 8vo. Pp. ix+494. (Kingston Hill: Technical Press, Ltd., 1946.) 45*s.* net.

LEWITT, E. H., Edited by. Pitman's Heat-Entropy Chart. Demy 8vo. Pp. 8. (London: Sir Isaac Pitman and Sons, Ltd., 1946.) 2*s.* net.

PERKINS, W. T., and BARTON, R. W. Radio-Communications. Cr. 8vo. Pp. viii +312. (London: George Newnes, Ltd., 1946.) 12*s.* 6*d.* net.

RICHARDSON, R. C. H. The Commissioning of Electrical Plant. (Monographs on Electrical Engineering.) Second revised edition. Demy 8vo. Pp. xii +372. (London: Chapman and Hall, Ltd., 1946.) 25*s.* net.

ZAMBONI, G. A. Additive Engine Oils. Imp. 8vo. Pp. 150. (London: Mitre Press, 1946.) 17*s.* 6*d.* net.

Chemistry : Chemical Industry

BELCHER, RONALD, and WILSON, CECIL L. Qualitative Inorganic Microanalysis: a Short Elementary Course. Cr. 8vo. Pp. viii +68. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 2*s.* 6*d.**

BOWEN, E. J. The Chemical Aspects of Light. Second edition revised. Demy 8vo. Pp. iv +300. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 15*s.* net.*

CAVELL, A. C. Chemistry for Junior Forms. Imp. 16mo. Pp. viii +296. (London: Macmillan and Co., Ltd., 1946.) 5*s.**

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LÉVY-HULOT, GEORGES. L'Analyse immédiate des bois. Roy. 8vo. Pp. 238. (Paris: Masson et Cie., 1946.) 450 francs.*

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Aircraft Exhibition at Radlett Aerodrome

The Society of British Aircraft Constructors recently held a flying display and static exhibition of aircraft, aero-engines, equipment and materials at the Radlett Aerodrome of Handley Page, Ltd. It was intended to appeal primarily to foreign and overseas users, and included both fighting service and civil machines. It was the first opportunity that the aircraft industry has had of displaying the progress that has been made during the war years, and the way in which the knowledge gained is being applied to the problems of civil air transport. More than 6,000 guests representing aviation in forty different countries attended, and it is already announced that the Avro Company has secured foreign orders worth some £2 millions and Messrs. de Havilland some £3 millions. A target of £16 millions in the next three years is confidently expected to be reached.

Fifty-five different types of aircraft were exhibited, ranging from a small two-three seat run-about of 1,500 lb. gross weight to a four-engined trans-Atlantic air-liner of 80,000 lb. The jet-propelled machines included a new Vickers-Armstrong *E*/10/44 Spiteful, with a speed of more than 600 m.p.h. with full military load. Equally fast was a new tailless jet-powered monoplane with swept-back wings, built by the de Havilland Aircraft Co. as an experimental model of the large aircraft of the future. One large four-engined experimental aircraft had a mixed power plant of two jet units and two piston engines driving airscrews. A helicopter demonstrated its ability to hover completely stationary over the aerodrome at the will of the pilot.

The most outstanding feature of the whole show was the way in which the lessons learnt during the War are being applied to air transport. For strategical reasons the British aircraft industry concentrated on the development of combat aircraft, while the production of transport aircraft was allotted to the United States. As a result Great Britain, although it lacks practice in heavy transport work, has accumulated experience in high-speed flight, including the use of the internal combustion turbine and jet propulsion, and also upon the principles of production. This is having a profound influence on both the design and competitive cost of the new civil aircraft coming forward.

Engineering at Dundee: Prof. W. T. Marshall

Dr. W. T. Marshall has been appointed to the chair of engineering at University College, Dundee. Dr. Marshall, who was born in 1907, received his early education at Westminster City School and later at the City and Guilds College, Imperial College of Science and Technology, at South Kensington. While at South Kensington he obtained, in 1928 and 1929, his degree of B.Sc. (Eng.) with first-class honours, the A.C.G.I., D.I.C. and, in 1939, Ph.D. On leaving College he had some five years experience with the British Reinforced Concrete Engineering Co. as reinforced concrete designer and afterwards further experience as engineering assistant with Messrs. F. A. Macdonald and Partners, of Glasgow, where he was mainly engaged on the design and construction of road bridges.

Later he returned to the City and Guilds College for nine years as lecturer in civil engineering, and during that time he was engaged on a number of Government researches (including 'Fido'). Immediately before this present appointment, Dr. Marshall was for one year technical officer to the Institution of Structural Engineers. He is a member of that Institution and an associate member of the Institution of Civil Engineers. Numerous publications on various problems in the theory and design of structures stand to his credit. Dr. Marshall will therefore bring to the chair a wide knowledge of teaching, research and practical experience.

British Iron and Steel Research Association: Mr. W. C. Fahie

Mr. W. C. Fahie, who joined the British Iron and Steel Research Association on March 1, has recently been appointed head of the Instrument Section in the Physics Department. Mr. Fahie took a degree in experimental and mathematical physics at University College, Dublin, where he later carried out research on the electrical measurement of short time intervals, band spectrum analysis and various applications of thermionic devices. He was commissioned in the R.A.F. on the outbreak of war and served as a signals officer in the Middle East, Malta and France. He was seconded to the American Air Force as signals planner for the invasion of Europe and was later signals planner in Combined Airborne Force Headquarters, where he served until the termination of the War.

Royal Commission on Awards to Inventors

The Royal Commission on Awards to Inventors, under the chairmanship of Lord Justice Cohen, has been set up as an independent tribunal to investigate the claims of inventors who allege that their inventions, drawings or processes have been used by Government Departments and Allied Governments during the War. The terms of reference, rules of procedure, and general instructions to claimants are contained in a pamphlet entitled "Royal Commission on Awards to Inventors 1946" (London: H.M. Stationery Office. 2*d.* net). This Commission follows the general lines of that set up in 1919 after the First World War, and a pamphlet entitled "Statement of the Principles Governing Assessment of Compensation Adopted by the 1919 Royal Commission on Awards to Inventors" has also been issued by the Stationery Office (6*d.* net).

The deputy chairman of the Commission is Mr. Kenneth Swan, K.C., and other members of the Commission are experts on different subjects. Thus Sir George Lee and Sir William Stanier are well-known engineers, Sir John Greenly is the chairman of Messrs. Babcock and Wilcox, Dr. G. M. Bennett was until recently professor of chemistry at King's College, London, and is now the Government Chemist, and Sir James Rae is the representative from the Treasury. Other eminent men of science and engineers will be co-opted to the Commission, depending upon the nature of the case to be heard. The secretary of the Commission is at present Mr. R. G. Lloyd, a member of the Patent Bar. Communications intended for the Commission should be addressed to the Secretary, Royal Commission on Awards to Inventors, Somerset House, Strand, W.C.2.

Revue d'Hématologie

A new journal devoted to blood, blood groups and blood transfusion is welcome. The *Revue d'Hématologie*, of which the first number has recently appeared, is the organ of the Research Laboratory

of the French National Blood Transfusion Centre in Paris. It is edited by Dr. Tzanck, director of the transfusion centre, and by Dr. Bessis, head of the research laboratory, with the help of a distinguished editorial committee. This journal will help to satisfy a need which has been felt for some time in Europe. The rapid advance made during the War in the field of blood groups—to mention only one aspect of the subject—has demanded much printing space. Indeed, the advance has been so rapid that by the time papers have been published in English quarterly journals of a general nature, with their long waiting lists, most of the original interest has been lost; for this reason, *Nature*, the *British Medical Journal* and the *Lancet* have borne the brunt of publishing blood-group work in Great Britain, of necessity in a concentrated form. Other rapid outlets are needed for more detailed and technical papers, and French workers in this subject are to be envied in the possession of their new journal. Perhaps the editors will consider publishing occasional papers in English. They have already shown an international spirit, for Sir Lionel Whitby launches the journal with an article on "Stockage et conservation du sang et de ses dérivés", and there is also an article by Race, Mourant and Macfarlane on "Travaux recents sur les antigènes et anticorps Rh avec une étude particulière de la théorie de Fisher". Papers by French authors are: "Les leucoses à plasmocytes" by Lamy and Willk, "Recherches sur la coagulation sanguine" by Tzanck and Burstein, "Contribution à l'étude de la cytologie sanguine" by Bessis, "Immunisation anti-Rh et pan-réactivation des anticorps anti-Rh. Description d'un nouveau test biologique" by Bessis, and also some useful notes on the technique of Rh testing. The *Revue d'Hématologie* is to appear quarterly and is published by Masson et Cie., Paris, and can be obtained in Great Britain through Messrs. H. K. Lewis and Co., Ltd., Gower Street, W.C.1; the annual subscription is 450 francs.

Indian-made Skis

At the request of the R.A.F. Rest and Leave Camp at Srinagar, Kashmir, an investigation into the possibility of making solid wood skis from Indian timber was carried out at the Forest Research Institute, Dehra Dun, India. The investigation and experimental work is described in two *Indian Forest Leaflets*, Nos. 78 and 79, 1945 (For. Res. Institute Publications, Civ. and Milit. Press, Pram Nagar, Dehra Dun). The common timbers in Europe for skis are ash and hickory, the latter being the better, whereas ash is the lighter. As might be expected, the requirements of timber for ski-making are very exacting. The wood must be tough, elastic, straight-grained, smooth and capable of taking a good polish with wax. It must not be too heavy, nor warp or twist, and should wear well. The three Indian timbers tried were *Terminalia tomentosa* (laurel wood of Great Britain), *Dalbergia sissoo* and *Artocarpus hirsuta*. None of these timbers appears to be ideal for the purpose. The sissoo and laurel are too heavy, and the *Artocarpus* does not appear to wear well. These experiments are described in Leaflet No. 78, entitled "Bending of Skis". Leaflet No. 79, entitled "Laminated Skis", carries the problem further. After discussing the advantages of laminated skis in a country in which temperatures and moisture are so varied as in India at different periods of the year, it is stated that a method of making laminated skis from Indian timbers using water-resistant phenolic resin adhesives has been devised. Skis so made from *Terminalia tomentosa* and *Artocarpus hirsuta* have been found satisfactory. Lamination, it is said, facilitates seasoning, effects a better utilization of wood, as material too small for other purposes can be used; defects are reduced; it facilitates impregnation with resins in a more even manner and makes possible longer and stronger, especially curved, structures, than with solid wood. The investigations and methods are described in the two leaflets.

World Organisation of Museums

A paragraph in *The Times* of August 20 reported an American movement towards the establishment of an international organisation of museums. This envisages the promotion of: (1) international exchange exhibitions, (2) the exchange of museum specimens, (3) the exchange of staff, (4) the establishment of travelling scholarships, and (5) the establishment of an international school for training young men and women in museum work. Mr. Chauncey J. Hamlin, chairman of the Policy Committee of the American Association of Museums, and president of the Buffalo Museum of Science, has visited several European countries, and this has resulted in the formation of committees (which will work upon the proposals) in France, Switzerland, Holland and Belgium. It is to be noted that each of these committees is composed of leading museum officials. Mr. Hamlin has also been in touch with officials of the United Nations Educational, Scientific and Cultural Organisation, and before his return to America he was in London to discuss with the Museums Association and directors of leading British museums the possibility of the formation of a British committee to work along the same lines.

The Electron Microscope

The separate revised publication of a lecture given to the Queckett Microscopical Club in February 1945 provides the general biologist with a very useful half-crown's worth of information ("Introduction to the Electron Microscope." By F. E. J. Ockenden. Monographs of the Queckett Microscopical Club. Pp. 24+8 plates. London: Williams and Norgate, 1946. 2*s*. 6*d*. net). It is in no sense a user's handbook complete with all the necessary technical details required by the user of the instrument, still less is it a summary of all the more important results obtained with it. Some recent technical developments of the first importance, notably the gold replica method of Williams and Wyckoff with which some startlingly beautiful stereoscopic pictures have been published in *Nature* (among other places) this year, have been omitted entirely. Nevertheless, as a sample of what this important new instrument is concerned with, the uninformed general reader could do much worse than read this pamphlet; and if it whets his appetite for closer acquaintance with the real thing no harm will have been done.

The British Institution of Radio Engineers

The British Institution of Radio Engineers has recently issued its twentieth annual report, which covers the activities of the twelve months ended March 31, 1946. The main object of the Institution is the advancement of the practice of radio engineering, not only by the promotion of meetings and conferences by which the dissemination of technical knowledge is effected, but also by such other activities

as will improve the training of radio engineers and secure better recognition of the status of the profession as a whole. The Institution has attempted to improve the education of the young radio technician, not only by the conduct of its own graduateship examinations which continue to attract an increasing number of candidates each year, but also by co-operating with other interested bodies in an attempt to establish suitable national courses of training in the various branches of the telecommunications field. Accounts of the work of the various committees of the Institution during the past year are contained in the report referred to above; and at the twenty-first annual general meeting held on September 25 the Council unanimously recommended the election of Admiral Lord Louis Mountbatten as president of the Institution for the year 1946–47.

Copies of *Nature* for Service Men in Italy

Lieut.-Colonel J. C. Castle wrote a year ago from the Directorate of Disposals in Italy (see *Nature*, August 4, 1945, p. 140) asking for unwanted copies of *Nature* to be sent to him for the use of service men stationed in Italy. There was a good response to this appeal. Colonel Castle now writes that his unit is being disbanded, and no further copies should be forwarded to him; he asks us to thank, on his behalf and on behalf of the troops who also received these copies of *Nature*, those anonymous senders who have been forwarding copies of the journal to him.

Diffusion in Solution

The *Annals of the New York Academy of Sciences* (46, 209; 1945) contains six papers by I. G. Longsworth, C. O. Beckmann, M. M. Bender, E. M. Bevilacqua, E. B. Bevilacqua, D. M. French, A. R. Gordon, H. H. Harned, L. Onsager, J. L. Rosenberg, and J. W. Williams, dealing with various aspects of the diffusion of electrolytes and macromolecules in solution. The fundamental theory of diffusion and the mathematical treatment of the subject are adequately dealt with, and experimental methods described, references to the literature being given. Attention is directed to these papers, which are likely to interest workers in various fields.

The Night Sky in October

Full moon occurs on Oct. 10d. 20h. 40m. u.t., and new moon on Oct. 24d. 23h. 32m. The following conjunctions with the moon take place: Oct. 18d. 13h., Saturn 4° S.; Oct. 26d. 16h., Mars 2° S.; Oct. 26d. 23h., Mercury 4° S.; Oct. 27d. 11h., Venus 7° S. In addition to these conjunctions with the moon, the following conjunctions occur: Oct. 10d. 12h., Mercury in conjunction with Jupiter, Mercury 2·2° S.; Oct. 21d. 01h., Mercury in conjunction with Mars, Mercury 2° S. The following occultations of stars brighter than magnitude 6 take place: Oct. 14d. 01h. 14·0m., 43 Taur. (*R*); Oct. 16d. 00h. 00·6m., 5 Gemi. (*R*); *R* refers to reappearance and the latitude of Greenwich is assumed. Mercury sets half an hour after the sun on Oct. 1 and is unfavourably placed for observation during the month. The planet attains its greatest eastern elongation on Oct. 31. Venus sets about 25 minutes after the sun on Oct. 1 and a few minutes after sunset on Oct. 31. The planet attains its greatest brilliancy on Oct. 13. Mars and Jupiter are unfavourably placed for observation in October. Saturn, in the constellation of Cancer, can be seen in the morning hours, rising at 0h. 17m., 23h. 27m. and 22h. 28m. at the beginning, middle and end of the month respectively. The stellar magnitude of Saturn is 0·5 during October.

It is possible that there will be a short meteor shower on Oct. 10, most likely in the early morning hours, but it may occur before midnight on Oct. 9. These meteors are the debris of Comet Giacobini-Zinner, and the radiant will be in the head of the Dragon. Moonlight will seriously interfere with observations, and it is quite probable that few—and those only the very bright meteors—will be seen.

Announcements

Prof. M. L. E. Oliphant, Poynting professor of physics in the University of Birmingham, will deliver the third Rutherford Memorial Lecture of the Physical Society on October 7 at 5.15 p.m. in the Royal Institution; he will speak on "Rutherford and the Modern World".

Mr. Geoffrey Heyworth, chairman of Lever Bros. and Unilever, Ltd., and vice-chairman of its sister company, Lever Bros. and Unilever My., has been appointed chairman of the Advisory Council for Scientific and Industrial Research, in succession to Lord Riverdale, who is retiring after holding the appointment for nine years. Prof. H. W. Melville, professor of chemistry in the University of Aberdeen, has been appointed a member of the Council, in succession to Sir Franklin Sibly.

The Medical Research Council has recently received from Sir Leonard Rogers a further generous addition to the endowment for research in tropical medicine with which he originally entrusted the Council in 1926. The capital value of the fund thus created is now approximately £15,000. The income is applicable to special purposes within the general field of tropical medical research.

Prior to 1939 the Departments of the History and Philosophy of Science and of the History of Medicine at University College, London, which were the only departments of their kind in Great Britain, provided either full-time or part-time postgraduate courses of one and two years. On an average they accommodated 30–35 students. With the return of University College to London last year, the study of these subjects has been revived. Prof. H. Dingle is now in charge, and under his supervision courses in the history of science are being provided.

A branch meeting of the Association of Special Libraries and Information Bureaux will be held in the Hornby Library, William Brown Street, Liverpool 3, at 3 p.m. on October 18. Mr. A. B. Agard Evans, of the Ministry of Works, will speak on "Information Service and the Export Trade". Mr. R. Brightman will be in the chair. Particulars can be obtained from Miss L. Wolff (hon. secretary), I.C.I. Ltd., Dyestuffs Division, Hexagon House, Blackley, Manchester 9.

The following appointments to the post of provincial director in the National Agricultural Advisory Service have been made: South-East Province, Mr. Eric Rea, at present agricultural adviser to Messrs. R. A. Lister and Co., Dursley; South-West Province, Mr. Colin D. Ross, at present executive officer to the Devon War Agricultural Executive Committee (in place of Mr. W. T. Price, who has resigned on appointment as principal of Harper Adams Agricultural College).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Moulds Producing Penicillin-like Antibiotics

It has already been found that penicillin-like antibiotics are produced by a number of moulds besides *Penicillium notatum*, including species of both *Penicillium* and *Aspergillus*[1-15].

Penicillin-like antibiotics have now been shown to be produced by a further five species of *Penicillium*:

P. steckii Zal. National Collection of Type Cultures No. 3950. The observation that this mould produced an inhibitor active against *Staph. aureus* but not against *Bact. coli* was reported by Wilkins and Harris[16].

P. chloroleucon Biourge.

P. asperulum Bain.

P. crateriforme Gilman and Abbott (Daltilo-Rubbo's strain).

P. griseo-fulvum Dierckx.

The last four strains were kindly supplied by Prof. J. Westerdijk, of the Centraalbureau voor Schimmelcultures, Baarn.

In each case the antibacterial activity developed on a number of media, of which the best was modified Czapek-Dox with lactose substituted for glucose, and with the addition of corn-steep liquor.

The antibiotics produced on this medium all had the following properties: active against *Staph. aureus*, not against *Bact. coli*; extracted into organic solvents at pH 2 and re-extracted into water at pH 7; inactivated by acid and alkali; slowly inactivated by heating at pH 7; completely inactivated by penicillinase and by copper ions. The combination of these properties is satisfactory evidence of the penicillin-like nature of the active substance. The antibiotic from *P. chloroleucon* was completely inactivated by methyl alcohol, but with the other four antibiotics the inactivation by methyl alcohol was only partial.

P. steckii, *P. chloroleucon* and *P. asperulum* bear some resemblance morphologically to the *P. chrysogenum-notatum* group; the other two species are widely separated both from this group and from each other.

Two of us (F. J. P. and A. V. P.) are indebted to the Agricultural Research Council and the Medical Research Council respectively for personal grants.

M. E. Johns
Flora J. Philpot
A. V. Pollock

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Effect of Calcium on the Production of Botulinus *D* Toxin

Some time ago, Dr. K. F. Meyer, director of the Williams Hooper Foundation, told us that he had obtained high yields of botulinus *A* and *B* toxins on media containing filtered alkalinized corn steep liquor. Lamanna, McElroy and Eklund[1] have since reported similar results.

We were unable to obtain high yields of *D* toxin on corn steep media until we added back to the media the ashed precipitate from the alkalinized corn steep filtrate. Eventually we found that the ash could be replaced by calcium, in the form of the chloride, lactate, phosphate, carbonate, etc. The optimum amount of soluble calcium was about 30 mgm. per cent. The media contained 0·5–1·5 mgm. per cent before the addition of calcium. The addition of lactic acid or calcium lactate to media containing excess calcium carbonate resulted in further improvement. The medium now used is prepared as follows. Unconcentrated corn steep liquor is precipitated at pH 8·5–9·0. The precipitate is removed and the liquor diluted with an equal amount of water. Thirty mgm. per cent calcium is added as lactate, together with 0·5 per cent calcium carbonate. The pH is adjusted to 7·2, and the medium sterilized at 15 lb. pressure.

An interesting point was the relatively large amount of iron required for adequate toxin production. The optimum was about 6 mgm. per cent, but amounts as high as 60 mgm. per cent did not lower toxin yields. Iron, magnesium and phosphorus were, however, present in sufficient amounts in the steep, and the major deficiency was calcium.

A typical result is shown in the accompanying table.

Corn steep medium precipitated at pH	Calcium added	Value of toxin	
		No. M.L.D. per c.c. for mice	* Prov. units antitoxin bound by 1 c.c.
7·5	Nil	No growth	No growth
8·5	Nil	No growth	No growth
9·0	Nil	No growth	No growth
9·0	$CaCl_2$	$>10^6$	500
9·0	$CaHPO_4$	$>10^6$	250
9·0	$CaCO_3$	$>10^6$	500
9·0	$Ca(C_3H_5O_3)_2$	$>10^6$	1000

* Prov. = provisional laboratory units.

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Poly-agglutinable Red Cells

In a recent communication in *Nature*, Basil-Jones, Sanger and Walsh[1] described a case of puerperal pyæmia the red cells of which (Group *O*) were agglutinated at 20° C. but not at 37° C. by 45 out of 45 normal sera of all groups. The peculiar behaviour of these red cells appeared to be similar to that described by Levine and Katzin[2] and Gaffney and Sachs[3]. The latter authors described their phenomenon as 'poly-agglutinability' of red cells.

In 1943 we observed two cases which were similar to those eventually published by Gaffney and Sachs.

Case 1. ♀ aet. 29, Group *O*—incomplete abortion. Fresh, washed red cells were agglutinated at room temperature but not at 37° C. by 38/39 sera, selected from all four *ABO* groups. The degree of agglutination was variable. Repeated washing of the red cells with ice-cold saline and saline at 45° C. did not affect the agglutinability. The patient's serum contained α and β *iso*-agglutinins active at room temperature and 37° C. Non-specific cold agglutinins active against the patient's cells and group *O* cells though present at 5° C. were only very weak. The patient's red cells hæmolysed with tap water did not transmit the poly-agglutinability to other normal group *O* cell suspensions. They thus differed from red cells showing the Hübener-Thomsen-Friedenreich phenomenon.

The agglutinating property of normal sera for the patient's red cells could be removed by absorption at 5° C. with equal volumes of the patient's washed red cells. Recovery in saline at 37° C. of the agglutinin was also carried out from the cold-washed cells used for the absorption. The recovered agglutinin agglutinated at room temperature the patient's red cells but not normal red cells of groups *O*, *A*, *B* and *AB*. Therefore, though a cold agglutinin, it appeared to be specific for the patient's cells, and not the non-specific cold agglutinin.

Case 2. ♀ aet. 37, Group *O*—hysterectomy for parametritis. Qualitatively all the findings in Case 1 applied to Case 2. She was met six weeks after Case 1 and a further sample of Case 1 was obtained for comparison. By this time the red cells of Case 1 were agglutinated at room temperature by 97 only out of 144 sera: the red cells of Case 2 were agglutinated by 142 out of 143 sera. The reactions of Case 2's red cells were stronger than those of Case 1 at this time. The agglutinin recovered in saline from the red cells of Case 1 six weeks previously still agglutinated at room temperature the fresh red cells of Case 1 and more strongly those of Case 2. The two sera absorbed with the red cells of Case 1 six weeks earlier gave no reaction with the fresh sample of Case 1: one serum did not react with the red cells of Case 2, the other gave only a very weak agglutination. It is probable, therefore, that the atypical agglutinogens in both cases were identical.

These two cases appear to be similar to those of Gaffney and Sachs in so far as their red cells could absorb from normal sera the agglutinins against themselves. They may differ from the case of Basil-Jones *et al.* in that the recovered agglutinin was specific at room temperature for the peculiar cells of the two patients and did not react with normal *O* cells. Gaffney and Sachs make no report on a recovered agglutinin.

Prof. Sachs kindly supplied us with a culture of Friedenreich's *M* bacillus which consistently, when grown in suspensions of red cells, leads to 'pan-agglutinability' of such suspensions by normal sera. Suspensions of three group *O* red cells were inoculated with *M.* bacilli; after nine days they were pan-agglutinable.

These cells were set up against six normal sera, saline extracts recovered from the agglutinated red cells of Cases 1 and 2, sera absorbed with the red cells of Case 1, and the sera of Cases 1 and 2.

The normal sera and the saline extracts of the patients' agglutinated cells both caused, at room temperature, strong agglutination of the transformed cells. The absorbed sera gave no agglutination with one of the transformed red cell suspensions and weak agglutination with the other two. The serum of Case 1 also showed a diminished agglutinating power, agglutinating one of the suspensions weakly but not the other two. The serum of Case 2, however, agglutinated almost as strongly as normal sera all three suspensions.

The results do suggest that the agglutinin in normal serum for the cells of these patients is related to the anti-*T* (of Friedenreich)

which agglutinates red cells transformed with *M* bacillus, in that the saline extracts agglutinated transformed cells and in that the absorbed sera showed diminished activity. In view of the fact that the serum of Case 2 agglutinated the transformed cells but not the red cells of Case 2 it is not yet possible to show more than a relationship. Shortage of material precluded further investigations. (Case 2 died. The husband of Case 1 did not approve.)

Neither our own cases nor those previously reported by Levine and Katzin, Gaffney and Sachs, and Basil-Jones *et al.* have been as exhaustively investigated as they might have been. One required to know whether the anti-*T* agglutinin or the non-specific cold (auto-) agglutinin of normal sera or both may be responsible for the poly-agglutinability of these peculiar cells. Also it is suggestive that all the six cases so far noted have been of group *O*. If they all are instances of the same condition the probability of this occurrence is $< 0 \cdot 01$ (1/120).

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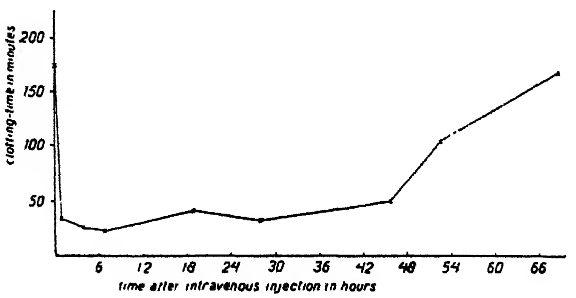
Use of Normal Human Plasma Fractions in Hæmophilia

The availability of separated human plasma proteins resulting from recent advances in fractionation methods[1] has provided the possibility of further investigations into the clotting mechanism in hæmophilia. It is of particular interest to find with which normal plasma fraction is associated the coagulation-promoting substance effective in hæmophilia[2], and to make a closer examination of this material. Important results have already been published on this subject[3].

As Kekwick, Mackay and Record[4] have developed a somewhat modified method of separating protein fractions, involving the use of ether rather than alcohol as in Cohn's method, it seemed desirable to examine the effect of their fibrinogen fraction in cases of hæmophilia. The clinical properties of the electrophoretically homogeneous fibrinogen obtained by these authors have not yet been examined, but we have been able to study the effect, in some hæmophiliac patients, of a product containing 82 per cent fibrinogen, 2·3 per cent albumin, 4·2 per cent γ-globulin, 11·2 per cent 'ill-defined' globulins migrating in the α and β region.

In vitro and *in vivo*, a 2 per cent solution of this 'fibrinogen' appeared to have a marked coagulation-promoting effect on hæmophilic blood. Repeated intravenous injection produced no disagreeable reaction, nor was it followed by a refractory period.



The accompanying graph shows the effect of the intravenous injection of 24 ml. of the fibrinogen solution into a patient with sporadic hæmophilia. To produce a comparable effect, both with regard to the shortening of coagulation time, and the duration of this shortening, would require at least ten times the volume of plasma. In some other cases in which a smaller amount of fibrinogen was injected, the effect lasted for a shorter time, but the antihæmophilic effect was about the same.

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Loss of Available Phosphate in Soil due to Micro-Organisms

While there is a considerable fund of knowledge on the physical and chemical factors affecting the loss of available phosphate, or 'phosphate fixation', in soils, there is very little published work on the part played by soil micro-organisms in the process. Phosphorus can either be utilized by micro-organisms as cell substance and hence locked up temporarily, or permanently, in much the same way as nitrogen, or according to unconfirmed work by Rudakov[1], phosphate can be reduced to phosphine and lost from the soil as such. In order to assess the importance and magnitude of these possible processes, some preliminary work on the problem has been carried out.

The amounts of phosphate taken up by different soils from solutions of KH_2PO_4 and commercial (19 per cent water-soluble P_2O_5) superphosphate were determined by shaking experiments and by use of a modified Lees and Quastel apparatus[2]. From the results obtained a garden soil with a relatively low uptake of phosphate was chosen for detailed experiments. A large sample of the soil was air-dried, sieved through a No. 6 B.S.S. sieve, thoroughly mixed and stored in cardboard containers. 100 gm. portions of soil were either shaken at intervals with 200 ml. of a solution of KH_2PO_4 or superphosphate containing 150 mgm. P_2O_5, or perfused continuously with a solution of the same concentration, for periods usually not exceeding two weeks. Determinations of P_2O_5 in the filtered solutions were made at various intervals.

The design of the experiments was to modify the microflora of the soil by physical and chemical treatment and to compare the subsequent uptake of P_2O_5 from solution with the microbiological activity, which, in turn, was measured by the carbon dioxide evolved.

(1) Sterilization of soil by heat, formalin, or phenol, or re-wetting air-dried soil, did not significantly alter the amount of phosphorus fixed. The increase in microbial cell substance following the re-wetting was evidently insufficient to affect markedly the amount of phosphorus fixed.

(2) The addition of certain substances such as peptone, urea, blood meal, at amounts calculated to give 0·07 per cent nitrogen and also of dextrose (0·5 per cent), which are easily decomposed by micro-organisms, substantially increased the amount of phosphorus fixed by soil; ammonium sulphate gave no significant increase in perfusion experiments.

The results are shown in the accompanying table.

Effect of addition of nitrogenous compounds (0·07 per cent N) and dextrose (0·5 per cent) to soil on the amount of P_2O_5 fixed and the CO_2 evolved

Substance added	Method of treatment	P_2O_5 fixed greater than control (mgm./100 gm. soil)	CO_2 evolved greater than control (mgm./100 gm. soil/100 hr.)
Peptone	Shaking	50	190
	Perfusion	30	
Urea	Shaking	30	68
	Perfusion	19	
Bloodmeal	Shaking	30	35
	Perfusion	13	
Ammonium sulphate	Shaking	11	−2
	Perfusion	3	
Dextrose	Shaking	51	—
	Perfusion	*	

* Soil column became water-logged on every occasion.

Using superphosphate in shaking experiments the amounts of phosphorus fixed were somewhat lower, but the different substances added were similarly effective (peptone 25, urea 15, bloodmeal 15, $(NH_4)_2SO_4$ negligible, and dextrose 22 mgm./100 gm. soil).

Additional proof that the excess phosphorus fixed by treated soils was due to micro-organisms was obtained by carrying out an experiment with sterilized soils and substances, under sterile conditions, the results of which showed that treated soils fixed no more phosphorus than the controls. In addition it was found that in the previously recorded perfusion experiments the additional amount of phosphorus fixed in soil treated with peptone or urea could not be removed by leaching.

From the preliminary work carried out it appears that the addition of phosphates only to the soil is unlikely to stimulate the microflora sufficiently to produce any significant fixation of phosphorus, unless the amount of phosphorus previously present is limiting for growth of micro-organisms. When, however, phosphates are added in conjunction with substances which are easily available as nutrients for growth of micro-organisms the biological fixation may be appreciable. Thus application of phosphatic fertilizers together with any substances which singly or together stimulate the soil microflora will tend to increase the total amount of phosphorus fixed.

All attempts to confirm the work of Rudakov[1] were unsuccessful. Samples of different soils to which 1·0 per cent KH_2PO_4 was added were adjusted to different moisture contents, with and without the addition of different substances such as glucose, and were incubated for long periods. A slow current of air was passed over the soils and into sodium hypochlorite solution. In no case were significant amounts of phosphorus found in the hypochlorite solution, and it is consequently concluded that if phosphate is reduced to phosphine biologically in soils the conditions must be rare and specialized.

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Leather-Jacket Control with Benzene Hexachloride and with D.D.T.

THE leather-jacket is a serious pest in fine turf culture and annually takes toll of considerable acreages. In the past the chief methods of control have involved the use of lead arsenate or an emulsion of orthodichlorobenzene. Lead arsenate is costly while the ortho-dichlorobenzene emulsion is not lethal and its use involves the necessity of sweeping the anæsthetized grubs from the surface. The possibilities of the new insecticides D.D.T. and 'Gammexane' have been investigated by us in a series of trials in the autumn (1945) and spring (1946). Field trials were laid down at a number of suitable centres chiefly on the Lancashire seaboard, and confirmation of the results obtained has come from practical tests carried out throughout the British Isles.

Using a replicated random block lay-out on areas of turf known to be infected, various rates of both D.D.T. and 'Gammexane' were tested. The living leather-jacket population at all relevant times was measured by counting the leather-jackets which could be brought to the surface by means of orthodichlorobenzene emulsion within a 6-in. sq. frame, making nine random throws on each experimental plot. The original population varied from as few as 50 per sq. yd. at one centre (where little damage was evident) to well over 1,000 per sq. yd. at another (where the turf was being seriously damaged). Satisfactory results were obtained in one to three weeks from application of either D.D.T. or 'Gammexane' at very low rates of application.

Using certain commercial 5 per cent D.D.T. powders, 100 per cent control could be obtained from ½ oz. per sq. yd., which represents only 0·025 oz. commercial D.D.T. per sq. yd. or about 0·02 oz. of the pure para para compound. Even lower rates of D.D.T. application were required when a 5 per cent emulsion was used. One gallon of such emulsion diluted with water to 400 gallons proved sufficient to give complete control over 800 sq. yd. of infected turf. This rate is equivalent to only 0·01 oz. of commercially pure D.D.T. per sq. yd.

'Gammexane' was tested in the form of powders containing 3½ per cent and 5 per cent benzene hexachloride, of which 13 per cent is actually gamma isomer. A suitable rate of application for complete control proved to be the equivalent of 1 oz. of the 3½ per cent formulation per sq. yd. This provides only 0·0045 oz. of the gamma isomer of benzene hexachloride.

A liquid preparation of benzene hexachloride was not available to us in time for the trials. It is proposed to test this and a further number of D.D.T. preparations (including pastes and wettable powders) this autumn. At the same time it is hoped to find out whether from last season's treatments there are any residual effects on this season's broods of leather-jackets.

A fuller account of this work will be published in the next issue of the *Journal of the Board of Greenkeeping Research.*

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Modern Insecticides and their Use against Wireworms

No chemical means of wireworm control have so far been effective and the farmer's only means of combating the ravages of this pest have been cultural.

In view, therefore, of the potentialities of the new insecticides, D.D.T. and 'Gammexane', in this connexion, simple laboratory experiments were designed to investigate their possibilities.

Wooden boxes of known area were filled with soil and a definite number of wireworms (*Agriotes obscurus*) introduced into each. The population (wireworms in 1,000's per acre) was thus known. Before introduction the wireworms were graded in size, so that the potential attacking power was the same in each box.

A series of eight boxes, in four pairs, was used, boxes Nos. 2, 4, 6 and 8 being untreated controls, while Nos. 1, 3, 5 and 7 were treated as follows:

Box No.	
1.	'Gammexane', 2 cwt. per acre, broadcast.
3.	D.D.T. (Guesarol E.C. 5 per cent), 1 cwt. per acre, broadcast.
5.	'Gammexane', 1 cwt. per acre, 1 cwt. per acre, drilled with seed.
7.	D.D.T. (Guesarol E.C. 5 per cent), ½ cwt. per acre, drilled with seed.

In the case of boxes Nos. 1 and 3, the insecticide was evenly broadcast over the surface and lightly raked in, while in boxes Nos. 5 and 7 it was evenly placed along the bottom of two 'V-shaped' furrows, 1 in. deep and 5 in. apart, running along the length of the box.

Spring oats, previously soaked until germination had begun, were then sown at the rate of 1,500,000 seeds per acre, being placed in two drills 1 in. deep and 5 in. apart (in boxes Nos. 5 and 7 the seeds were placed in the previously prepared furrows directly on top of the D.D.T. and 'Gammexane') and covered with soil.

It should be pointed out that conditions were in favour of wireworm attack, no manurial treatment being given to assist the plants to 'grow away' and no consolidation and preparation of a good seed bed taking place. Also the fact that the seeds had germinated before sowing ensured that they were all viable.

All boxes were then placed outside and examined daily to determine (1) the number of plants which successfully appeared above the surface; (2) the number of plants afterwards attacked.

After nineteen weeks, the oats from each box were threshed, the yield weighed and the soil examined to determine wireworm mortality.

The results, which it is hoped to publish in detail later when parallel field trials have been completed, are of much interest and show definite beneficial effects from the use of D.D.T. and 'Gammexane'.

Briefly, they are as follows:

Box No.	% plants successfully appearing above surface	% plants afterwards attacked	Yield
1. 'Gammexane' broadcast	100	0	8·5 gm.
2. Control	81	50	3·3 gm.
3. D.D.T. broadcast	92	9	9·6 gm.
4. Control	70	23	4·8 gm.

Regarding wireworm mortality, all those recovered from the controls were normal, healthy and active, while those from the treated boxes, several of which were dead, were sluggish and apparently unable to control their movements. In view of previous observations on wireworms after D.D.T. and 'Gammexane' treatment (unpub.), it was considered that none would recover and therefore mortality was classified as 100 per cent as against none in the controls.

Boxes Nos. 5, 6, 7 and 8 generally did not give such definite results because for some unknown reason wireworm attack did not occur on any scale even in the controls. However, here again, on examining the soil, the mortality was much higher in the treated boxes, although some (up to 14 per cent) did occur in the controls.

Therefore, although the above conditions are somewhat artificial and from them field deductions cannot be definitely made, it appears that with further investigations using these insecticides, the answer to the wireworm menace may be in sight.

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Kinetics of Aromatic Nitration: the Nitronium Ion

MARTINSEN (1904) first obtained a definite kinetic order for the nitration of aromatic substances. His solvent was sulphuric acid, and his demonstration[1] of second-order kinetics in this medium has since been fully confirmed[2,3]:

$$\text{Rate} = k_2[\text{ArH}][\text{HNO}_3] \quad (\text{in } H_2SO_4) \qquad (1)$$

Benford and Ingold obtained the first well-defined kinetic results in any solvent other than sulphuric acid. With nitromethane as solvent, and nitric acid in constant excess, they demonstrated zeroth-order kinetics[4]:

$$\text{Rate} = k_0 \quad (\text{in organic solvents, } [\text{HNO}_3] = \text{const.}) \qquad (2)$$

This insensitiveness of the rate to the concentration and nature of the aromatic compound applied only to relatively reactive compounds, such as benzene and toluene. With less reactive compounds, such as chlorobenzene, some dependence of the rate on the compound was observed. We have continued these experiments, and, for considerably less reactive compounds, such as *p*-dichlorobenzene and ethyl benzoate, have established first-order kinetics:

$$\text{Rate} = k_1[\text{ArH}] \quad (\text{in organic solvents, } [\text{HNO}_3] = \text{const.}) \qquad (3)$$

Benford and Ingold thought that their results were peculiar to nitromethane, but we have observed all the same phenomena with acetic acid as solvent.

This change of kinetic order clearly has the same importance for aromatic nitration as the similar discovery for alkyl halide reactions had for the mechanism of nucleophilic aliphatic substitution. Just as alkyl halides (or alcohols in acid media) may undergo a rate-determining heterolysis to a carbonium ion, so nitric acid must suffer a heterolysis, which may be rate-determining if the formed nitronium ion is sufficiently rapidly removed by the aromatic compound. (It will be appreciated that, as compared with the aliphatic case, the organic and inorganic reagents possess interchanged functions, aromatic nitration being an electrophilic substitution.) A slow heterolysis of nitric acid cannot depend only on proton transfers, and therefore the rate-limiting fission, leading to an electrophilic nitrating agent, must occur in an NO-bond, the only plausible interpretation being

$$O_2N \,\vdots\, -OH \rightarrow O_2N^+ + OH^- \qquad (4)$$

The actual mechanism is considered to involve a preliminary proton uptake (as in the formation of carbonium ions from alcohols in acid media). The details differ according as the medium is more or less strongly acidic than nitric acid. Thus in sulphuric acid we assume

$$\left.\begin{array}{l} H_2SO_4 + HNO_3 \rightleftharpoons HSO_4^- + H_2NO_3^+ \\ H_2SO_4 + H_2NO_3^+ \rightleftharpoons HSO_4^- + H_3O^+ + NO_2^+ \end{array}\right\} \qquad (5)$$

and in organic solvents,

$$\left.\begin{array}{l} 2HNO_3 \rightleftharpoons NO_3^- + H_2NO_3^+ \\ H_2NO_3^+ \rightleftharpoons H_2O + NO_2^+ \end{array}\right\} \qquad (6)$$

We have observed a strong acceleration on the addition, in organic solvents, of an acid (for example, H_2SO_4) stronger than nitric acid, the catalysed reaction still showing zeroth-order kinetics under suitable conditions.

Euler (1922) first envisaged the nitronium ion, NO_2^+, as a nitrating entity[5], and the idea has since been frequently supported[6,3]. Our deduction[7] alike of the formation and effectiveness of NO^2+ from the change of kinetic order on nitration seems particularly certain and direct. Since an independent species is needed to remove the aromatic proton, the rate equation for the nitration mechanism may be written

$$\text{Rate} = k[\text{ArH}][NO_2^+][\text{Base}] \qquad (7)$$

In a later note in *Nature* we shall offer proof that nitric acid in sulphuric acid as solvent is in fact converted completely into NO_2^+. Reactions (5) thereby become consistent with kinetics (1) for nitration in sulphuric acid. Bennett and Williams have shown that the bisulphate ion is the principal proton acceptor in this case[3].

Reactions (6) likewise correspond to kinetics (2) and (3) for nitration in organic solvents. Sufficiently reactive aromatic compounds remove the NO_2^+ as fast as it is formed, whereas much less reactive compounds allow it to approach a small equilibrium concentration. Both the zeroth- and first-order rate constants are reduced by added nitrate ions, according to a law of the same hyperbolic form. This can be explained by equations (6), essentially as a consequence of the assumed preliminary proton transfer leading to the nitracidium ion, $H_2NO_3^+$. Both the zeroth- and first-order reactions are retarded by 'nitrous acid', but this effect we refer back to that observed with nitrate ion.

The connexion between the two effects emerged in the course of another investigation, which was undertaken jointly with Mrs. F. M. Garforth, in order to elucidate the nature of 'nitrous acid' in solvents containing nitric acid. Studies by the methods of optical absorption and electrical conductivity have led to the conclusion that the condition of 'nitrous acid' is essentially the same as that of added N_2O_4, but that this exists as a binary electrolyte, one of its ions being the nitrate ion.

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Sept. 2.

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Structure of Catalytic Metal Films

Evaporation of metals on to the walls of a glass tube at room temperature is known to yield films of high catalytic activity in many instances. In the case of tungsten a film of apparent area 140 cm.[2] and estimated weight of order 1 mgm. was found[1] by two methods to possess an area of 450 cm.[2]. It was concluded "that the film was probably not microcrystalline to any great extent", but this conclusion is now found to be invalid. These results, together with other data, are best explained by assuming that the film is microcrystalline, in accordance with the results of electron diffraction[2]. The crystallites of a sputtered platinum film have a side of $\sim 0.005\,\mu$ by the latter method. Taking a simple model of equal spheres exposing all their surface to the reacting gas, we calculate for the above tungsten film a crystal diameter of $0.007\,\mu$. By itself, of course, the chemical evidence cannot decide whether the particles are crystalline or amorphous.

The results of Beeck, Smith and Wheeler[3] would seem to allow an extension of the argument. They found that films of nickel on glass formed by evaporation in high vacuum showed crystalline electron diffraction patterns, and that the true area measured by the chemisorption of hydrogen or carbon monoxide increased *linearly* with the weight of metal deposited, over the range examined (5–50 mgm.). The 50 mgm. film had an area of 4,200 cm.[2], which they discuss in terms of pore structure. On our view, complementary to theirs, the film is made up of approximately uniform crystallites of diameter $0.043\,\mu$. During evaporation, once a crystal reaches this diameter approximately, it ceases to grow and a new nucleus starts, this diameter probably being a function of the experimental conditions.

The 0·1 mgm. nickel film of A. and L. Farkas[4] possessed a true area of 150 cm.[2], corresponding to a particle diameter of $0.005\,\mu$. The first crystallites in this film (average thickness 1 atom) may still be in the growing stage. On the other hand, the difference from $0.043\,\mu$ may reside in the conditions of deposition, and traces of a strongly chemisorbed gas may well have a profound effect here. It may be calculated for the case of hydrogen on tungsten (taking Roberts's value of ΔH[5]) that adsorption from a pressure of 10^{-6} mm. might lower the surface tension of the metal by as much as 500 dynes/cm. This may well help to increase the degree of dispersion of the film.

It is seen that the relatively small ratio of true to apparent area observed with films of only a few atoms average thickness is, in fact, misleading. The present view is in much better accord with the physical evidence.

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Influence of the Nature and Concentration of Supporting Electrolyte on Polarographic Diffusion Current

When determining traces of impurities in zinc alloys it was found to be of interest to study the behaviour of the diffusion current in supporting electrolytes of high concentration.

Shaikind[1] has found that the diffusion current of Pb^{2+} and Cd^{2+}, when present at constant concentration, decreases with increasing concentration of supporting electrolyte, when the latter is $ZnCl_2$ or $ZnSO_4$, but remains constant when it is KCl or Na_2SO_4. He ascribes the decrease in current to the increase in viscosity, but has not made any direct measurements concerning this.

Gentry[2] has investigated the relation between the diffusion current of Tl^+ and viscosity in ethylene glycol – water mixtures, and has found the product of the diffusion current and the square root of the viscosity of the medium to be constant. This paper was not published until our investigation was finished.

We have studied the systems set out in the accompanying table.

Supporting electrolyte	Concentration range of supporting electrolyte moles/lit.	Metal
$ZnCl_2$	1·5–10	Cd, Pb, Bi, Tl
$ZnSO_4$	0·3–2·4	Cd
$Zn(NO_3)_2$	0·5–4·8	Cd, Pb
NaCl	0·9–4·6	Cd
NH_4Cl	0·9–4·6	Cd
Na_2SO_4	0·1–0·9	Cd
$MgCl_2$	0·5–4·2	Cd
$CaCl_2$	0·5–4·0	Cd
$AlCl_3$	0·3–2·7	Cd
KSCN	1·0–9·2	Ni

All measurements have been carried out in a thermostat at 25·0° C. The solutions were freed from oxygen, and gelatin was added in some cases at a concentration of 0·005 per cent as a maximum suppressor.

The concentration of the metal is given by x, and that of the supporting electrolyte by c.

In all the cases investigated, a strict linear relationship was found between x and the diffusion current i_d, when c was constant.

The experiments were carried out in two different ways: (1) Varying c, keeping x constant. (2) Varying c, keeping $x/c = p$ (a constant).

(1) In the first series the diffusion current was found to be a linear function of c, i_d in most cases decreasing with increasing c (Fig. 1).

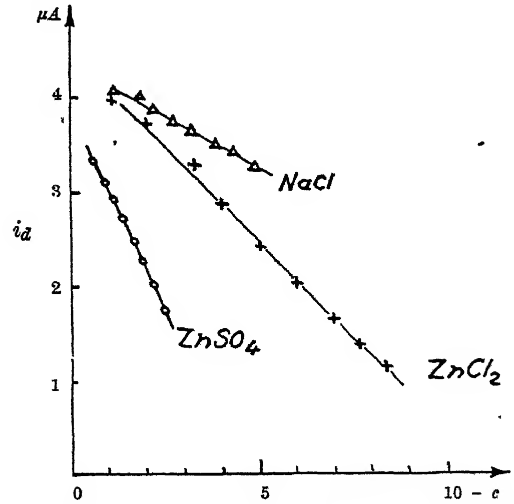

Fig. 1. Cd^{2+} IN VARIOUS SUPPORTING ELECTROLYTES (x IS CONSTANT)

The fundamental Ilkovic equation may in this case be written:

$$i_d = \text{const.}\ D^{1/2} \quad . \quad . \quad . \quad . \quad (1)$$

where D is the diffusion coefficient. According to Stokes–Einstein

$$D.\eta = \text{const.} \quad . \quad . \quad . \quad . \quad (2)$$

where η is the viscosity coefficient of the medium.

Measurements of viscosity have shown that there is a linear relationship between $\eta^{-1/2}$ and c in the concentration ranges given above:

$$\eta^{-1/2} = -\,a.c + b \quad . \quad . \quad . \quad (3)$$

where a and b are constants depending on the nature of the supporting electrolyte.

Combining (1), (2) and (3) we obtain

$$i_d = \text{const.}\ (-\,a.c + b) \quad . \quad . \quad (4)$$

In most cases it has been verified experimentally that the constants a and b are the same for any given supporting electrolyte, whether determined by polarographic or viscosimetric measurements.

It is interesting to note that in the case of a supporting electrolyte of NH_4Cl, where η decreases with increasing c, the diffusion current of Cd^{2+} also increases with increasing c, as was to be expected.

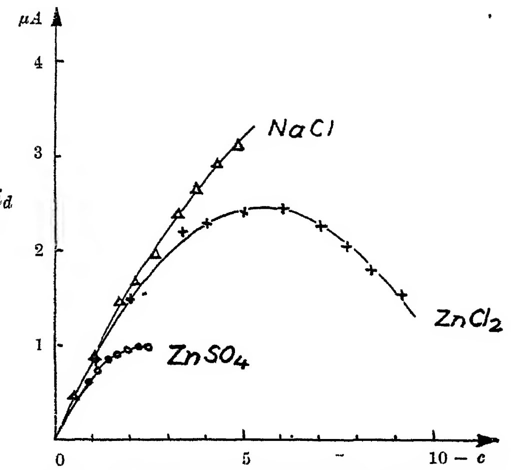

FIG. 2. Cd^{2+} IN VARIOUS SUPPORTING ELECTROLYTES (x/c IS CONSTANT)

(2) In the second series the diffusion current was found to be a parabolic function of c in solutions where (3) is valid (Fig. 2).

The Ilkovic equation may now be written :

$$i_d = \text{const. } D^{1/2}.x \quad . \quad . \quad . \quad (5)$$

Substituting $x/c = p$ and (4) in (5) we obtain

$$i_d = \text{const. } (-a.c + b).c.p \quad . \quad . \quad (6)$$

This equation shows that i_d has a maximum at $c = b/a$. In order to obtain the greatest possible accuracy in determining traces of impurities in a product, when the product itself serves as the supporting electrolyte, this concentration $c = b/a$ should be the optimal. However, it is not always possible to reach this optimal concentration, since the solubility of the supporting electrolyte is limited.

An investigation of Cd in $ZnCl_2$ did not show any change in optimal concentration with temperature (25, 50, 75° C.).

From the above it may be concluded that it is necessary to keep c absolutely constant when carrying out polarographic determinations in supporting electrolytes of high concentration. Another possibility is to work with methods allowing for variations in the nature and concentration of the supporting electrolyte, for example, Forche's[3] pilot ion technique.

A fuller account of this investigation will be published elsewhere.

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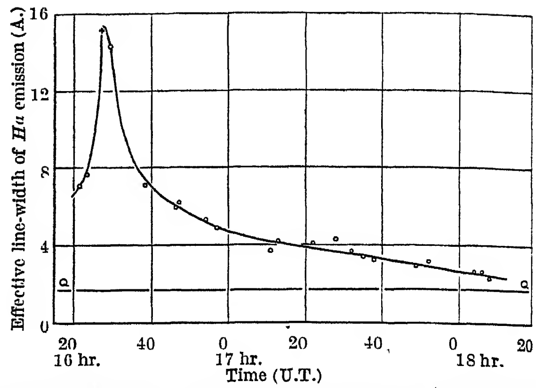
Spectrographic Observations of the Solar Flare of July 25, 1946

THE course of this flare was fully observed at Sherborne between 16h. 15m. and 18h. 10m. with the combined spectrohelioscope and spectrograph[1].

Measures of effective line-width, made with the spectrohelioscope line-shifter upon the brilliant reversal of the $H\alpha$ (λ 6563) contour, establish that the peak intensity of the flare radiation occurred at 16h. 27m. ± 1m. The shape of this curve, illustrating the variation of line-width against time, confirms previous results[2] obtained here by indicating the occurrence of what can be most appropriately described as a *radiation burst*, lasting for two or three minutes, at the commencement of a great flare. The subsequent history was one of slow decay over a period of about two hours.

Seven spectra (λ 4750–λ 6800), in the first and second orders of the 13-ft. spectrograph, were obtained between 16h. 25m. and 17h. 15m. One of these, taken at 16h. 27m., being closely coincident with the peak of flare intensity, is of special interest. The principal features are : (1) the brilliant reversal of the $H\alpha$-line, at least 15 A. wide ; (2) strong emission of helium, λ 6678, and reversals of two silicon lines, $\lambda\lambda$ 6347·1, 6371·4 ; (3) a narrow bright streak, representing enhancement of the continuous spectrum, commencing at about λ 6450 and gradually increasing in intensity towards shorter wave-lengths. A plate of the D-region of the spectrum, taken at 16h. 35m., shows helium D_3 (λ 5876) in emission over the flare filament and in absorption over the penumbra of the sunspot. On the other hand, the sodium lines, D_1 and D_2, reported as seen in reversal during previous flares, were not appreciably affected at this time.

From the appearance of helium λ 6678 (2^1P–3^1D) in emission, we can infer the existence in the flare radiation of λ 584 (1^1S–2^1P), with its powerful influence upon atmospheric ionization. Allen has previously reported[3] an observation of this line in emission, but Richardson and Minkowski[4] were unable to detect it in any flares seen upon the disk.



O, VISUAL MEASURES WITH SPECTROHELIOSCOPE ; + (NEAR PEAK), MEASURED FROM SPECTRUM PLATE AT 16 HR. 27 MIN. QQ, LINE-WIDTH OF QUIESCENT BRIGHT HYDROGEN.

Former flares have been recorded by monochromatic light, usually of the $H\alpha$-line. The sole exception was the phenomenon of September 1, 1859, which, by reason of its characteristic geomagnetic effects, was recognized by H. W. Newton[5] as the earliest, and possibly the greatest, of recorded flares. This became visible for a few minutes in integrated light and was seen independently by Carrington and Hodgson as a pair of brilliant patches over the giant sunspot, both observers using ordinary telescopic means. The enhancement of the continuous spectrum may be taken to represent the occurrence of a similar phenomenon on July 25, 1946.

Comparisons of the spectra taken before and after the peak intensity of 16h. 27m. lead to the conclusion that most of the characteristic features referred to are confined to the very short period of the radiation burst. It is also to be expected that the maxima of those immediate geophysical effects of a great flare (magnetic 'crochet' and radio fade-out) will be found to coincide in time with this flash of radiation.

A more detailed examination of the spectra will be published later.

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Interpretation of the Meson Spectrum Near Sea-Level

THE spectrum of the mesons near their place of production can be deduced from the spectrum observed near sea-level. The probability of a meson reaching sea-level with a final momentum p is, according to Euler and Heisenberg[1], given as follows :

$$P_{p_1}(p) = \left\{\frac{q}{p_1}\left(1 + \frac{q - p_1}{p}\right)\right\}^{-\frac{p_\tau}{p+q}}. \qquad (1)$$

All quantities have been expressed in terms of momenta, the symbols having the following meaning :

q = 2,000 Mev./c., the momentum loss on traversing the atmosphere.

p_1 = 200 Mev./c., the momentum loss on traversing the atmosphere lying above the meson-producing layer.

$p_\tau = \mu c \dfrac{H}{c\tau}$ = 1,270 Mev./c., with H the height of the homogeneous atmosphere, τ the average life of the meson, μ mass of the meson.

Equation (1) is based on the assumption that all mesons are formed at the same height. We have investigated the alternative assumption that the mesons are formed by primaries which are absorbed exponentially in the atmosphere, thus giving rise to an extended production layer. The average probability of a meson formed in this layer reaching sea-level with a final momentum p is thus

$$\bar{P}_{p_1}(p) = \int_0^q e^{-p^1/p}\, P_{p^1}(p)\, \frac{dp^1}{p_1}. \quad . \quad (2)$$

We find that the integral (2) is in good approximation given by

$$\bar{P}_{p_1}(p) \approx \left(\frac{p_\tau}{p+q}\right)!\; P_{p_1}(p). \quad . \quad . \quad (3)$$

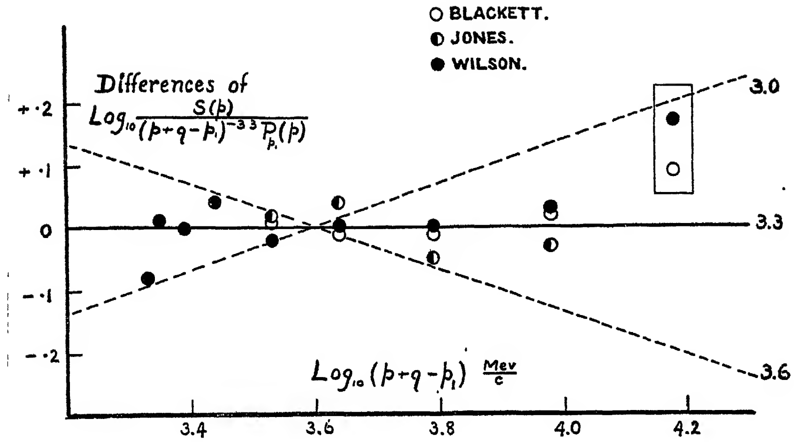
The factorial appearing in (3) always has numerical values between 0·9 and 1·0. Thus the difference between $\bar{P}$ and P is unimportant and the expression (1) can be assumed to refer to an extended layer as well as to a single layer of production.

The differential meson spectrum at sea-level, S, can be expressed in terms of S_0, the spectrum at production, in the following way :

$$S(p) = S_0(p + q - p_1)\, P_{p_1}(p), \quad . \quad . \quad (4)$$

except for the very small range, irrelevant for our purpose, in which increased ionization takes place at sea-level.

Using the experimentally observed spectrum given in a preceding letter[2], and assuming that



$$S_0(p) \sim p^{-3.3}, \quad . \quad . \quad . \quad . \quad (5)$$

we find (4) to be reasonably satisfied. To show the agreement we have plotted in the accompanying illustration differences of

$$\log \left\{ \frac{S(p)}{(p+q-p_1)^{-3.3}\, P_{p_1}(p)} \right\}$$

from an arbitrary zero against

$$\log \{p + q - p_1\}.$$

The observed points lie reasonably well on a horizontal line, supporting equation (5).

We indicate by broken lines in the illustration the changes of slope in the scale of the diagram, which correspond to exponents 3·0 and 3·6 in place of 3·3; the experimental points are clearly inconsistent with so large a variation from the latter figure.

The above analysis is very similar to that of Euler and Heisenberg, which leads to an exponent 2·87 instead of the exponent 3·3 we find here. The present value is based on much more extensive observational material and is, therefore, probably the more reliable value.

An appreciable deviation is noticeable in the diagram for the points at $\log_{10}(p + q - p_1) = 4{\cdot}18$. This undoubtedly occurs because at this momentum the limit of resolution of the measuring equipment is approached. It was first pointed out by Blackett that at momenta greater than this limit the apparent measured differential spectrum is determined solely by errors of measurement and must be of exponent − 2. The deviation which occurs is in accord with the observed resolution of the spectra concerned.

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[1] Euler and Heisenberg, *Ergeb. exakt. Naturwiss.*, **17**, 1 (1938).
[2] *Nature*, **158**, 414 (1946).

Thermal Migration of Macromolecules

Debye has reported[1] that the velocity of thermal diffusion, relative to that of ordinary diffusion, is much greater in polymer solutions than in simple solutions. This result is likely to arouse a great deal of interest, and the following recent observations of our own concerning thermal diffusion in solutions of polymethyl methacrylate in various solvents may therefore be opportune.

Unlike Debye and his co-workers, we have not found it necessary, in order to demonstrate the effect, to use a method as elaborate as that of Clusius and Dickel. The process is so rapid, and the concentration gradient so great, that the reduction of viscosity in the region of high temperature is often more than compensated for by the local increase in concentration of the polymer solution. A very simple demonstration of these special features of the process is to place a beaker containing a cold solution of the polymer in toluene on a hot surface and then, a few seconds later, to detect the formation of a treacly layer at the bottom by careful scraping with a glass rod, or by watching adventitious bubbles. Alternatively, if a glass or metal tube, heated by a current of steam, be immersed in the polymer solution for about 10 minutes and then cooled, it will be found, on withdrawal, to have become coated with a layer of jelly.

In more elaborate experiments where the polymer solution was placed between two vertical brass plates, one heated and the other cooled, we have found the concentration of that part of the solution immediately in contact with the hot surface to increase two- or three-fold in a short period of time. For example, when a monochlorobenzene solution containing 3·1 per cent of polymethyl methacrylate by weight was confined in the cell for 2 hours, the temperatures of the hot and cold surfaces being approximately 115° C. and 14° C. respectively, and the distance between them 1 cm., the jelly adhering to the 'hot' wall when the cell was dismantled (after cooling) contained 8·8 per cent solute.

In thermal diffusion it must be supposed that the molecules have a real mean velocity caused by the unsymmetrical field of force arising from the temperature gradient. The resultant force will increase with the size of the molecule and the velocity therefore will remain of the same order of magnitude, or will increase with molecular size, as does the velocity of migration of polymer ions in an electric field. For this reason we consider that the process could more aptly be called 'thermal migration' rather than thermal diffusion.

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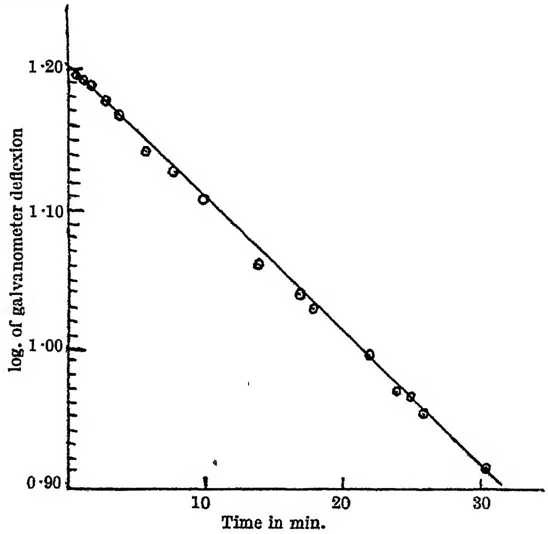
Fluorescence Fatigue

The fact that substances which fluoresce show a 'fatigue' or 'fading' when exposed continuously to the radiation causing fluorescence has been noted sporadically. Beese and Marden[1] investigated the 'fatigue' of several substances, mostly solids, and found that with intense radiation equilibrium was attained in about ten minutes, and that complete recovery was attained in the dark.

Little notice seems to have been taken of fatigue in the biological literature, although it is well known that certain substances such as riboflavin are light labile. The fading fluorescence of vitamin A, however, has been used in histological investigations and has been studied by Sobotka, Kann and Loewenstein[2].

In preliminary experiments designed to investigate the physics of the fluorescence of biologically important substances, I have found that fluorescent fatigue is present in all liquids so far investigated: for example, vitamin A, riboflavin, eosin, fluorescein, coproporphyrin. Moreover, the curves for the intensity of fluorescence against time are in some cases strikingly similar to curves of radioactive decay. For example, a dilute watery solution of comparatively pure riboflavin gives a straight line when the logarithm of the intensity of the fluorescent light is plotted against time. The figure shows a curve for a solution which had been kept in the dark up to the moment of irradiation.



It can be seen that the fluorescence of this sample had a constant rate of decay. The galvanometer readings continued to decrease until the change in a given time interval was of the same order as the fluctuations ordinarily present. Every experiment ended, not with an 'equilibrium' state of the fluorescing material, but with a rate of fading which could no longer be measured because of the limitations of the experimental set-up.

Apart from the importance of such data for an understanding of photodynamic action, fluorescent fatigue has an important practical aspect in that measurements of fluorescence intensity have become popular for the assay of biologically important substances. It is, however, apparent that the result of the 'fluorimetry' or 'fluorphotometry' of samples will depend on their previous history as regards exposure to light.

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[1] Beese, N. C., and Marden, J. W., *J. Opt. Soc. Amer.*, **32**, 317 (1942).
[2] Sobotka, H., Kann, S., and Loewenstein, E., *J. Amer. Chem. Soc.*, **65**, 1959 (1943).

Role of Inertia in Hydrodynamic Lubrication

On the basis of the hydrodynamic theory of lubrication presented by Prof. Osborne Reynolds in 1886[1], plane parallel surfaces in relative motion are incapable of developing a load-supporting oil film. This theory requires that the bearing surfaces be inclined to one another in the direction of motion. Recently, Mr. A. Fogg of the National Physical Laboratory reported[2] load capacities for parallel thrust surfaces, operating at high speeds, that were comparable to those obtained with conventional Michell or Kingsbury type thrust bearings. Similar results have also been noted by other researchers[3].

Mr. Fogg explains these anomalous observations on the basis of a temperature gradient along the oil film in the direction of relative motion. He likens the expansion of the lubricant accompanying this temperature gradient to an equivalent hydrodynamic oil wedge. This theory is shown to be in qualitative agreement with the observed data by a process of reasoning by analogy.

A mathematical analysis of the development of a load-supporting oil film by lubricant expansion has been made. As Mr. Fogg predicted, the expansion of the lubricant as it passes through the bearing is significant, particularly in the case of parallel surfaces. However, the results of this analysis are not in quantitative agreement with Mr. Fogg's observation that at high rotative speeds a pair of parallel plates will carry very nearly the same load as a comparable tilting pad bearing. The analysis rather shows the load capacity of parallel surfaces to be of the order of 1/5 to 1/10 that for an equivalent tilting pad bearing, the exact value depending upon the temperature rise and coefficient of expansion obtaining. Although Mr. Fogg's theory nicely explains why parallel thrust surfaces, for use at ordinary speeds, are generally designed to support a unit load of approximately 50 lb. per sq. in. while tilting pad bearings are designed to carry a load of the order of 500 lb. per sq. in., it does not explain the excellent performance of parallel surfaces at high rotative speeds. As Mr. Fogg points out in his paper[2], the influence of the coefficient of expansion of the lubricant should be included in the analysis of slider and journal bearings which operate with a large rise in temperature.

The unexpected load capacity of parallel plane surfaces can be qualitatively explained on the basis of the inertia-induced pressure developed in an oil film at high rotative speeds. Here the density of the lubricant is the physical property of interest. The inertia of the lubricant has been considered negligible in nearly all hydrodynamic lubrication investigations since the time of Osborne Reynolds. The relatively good agreement between theory and experiment for ordinary slider and journal bearings operating at slow or moderate speeds has amply justified the exclusion of inertia terms. The late Dr. A. Kingsbury[4] has stressed the need for an investigation of the influence of inertia upon the hydrodynamic characteristics of a bearing. However, a consideration of the magnitude of the centripetal component of acceleration led him to conclude[5] that the inertia of the oil in the film was of negligible importance even for bearings operating at high rotative speeds.

In addition to the centripetal component of acceleration, several other components act upon a particle of oil confined between two parallel rotating disks. These include linear, angular and Coriolis acceleration components. An examination of the hydrodynamic equations including inertia terms qualitatively accounts for the observed load capacity of parallel rotating disks. The fact that such a bearing carries an appreciable load only at relatively high speeds is in agreement with the inertia theory of lubrication.

A bearing specially designed to take full advantage of the inertia effect *at all speeds* has been built and tested. This device gives appreciably different curves when $\left(\frac{ZN}{P}\right)$ is plotted against the coefficient of friction at several low speeds, where Z is the absolute viscosity of the lubricant in centipoise, N is the speed in r.p.m., and P is the unit load on the projected area of the bearing. Such a multiplicity of friction curves is contrary to ordinary hydrodynamic theory but is in agreement with the inertia theory of lubrication. It is to be expected that careful friction tests of plane parallel disks, thrust bearings of fixed inclination and Michell- or Kingsbury-type bearings will indicate a similar, although smaller, dependence upon speed at high rotative speeds.

A full report of this investigation will soon be published elsewhere.

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The letter from Messrs. Shaw and Strang states that the behaviour of lubricated parallel surfaces, which I reported in a paper to the Institution of Mechanical Engineers in January 1945, is mainly due to the inertia and not, as I suggested, to thermal expansion of the lubricating fluid. While agreeing that the influence of thermal expansion must be included in the analysis of film lubricated bearings, they suggest that its effect is only of the order of 1/5 to 1/10 of a corresponding geometrical wedge. I should like to ask on what basis this comparison has been made. Has it, as seems probable, been made on the basis of a given mean film thickness with corresponding relative velocity and oil viscosity? If so, I suggest that this is not the correct basis for comparison, since the parallel surface bearing will run with a much lower film thickness before contact takes place than will a fixed taper or tilting pad bearing, for a given degree of surface finish. The fixed-taper surface will obviously fail by contact at the trailing edge when the mean film thickness is relatively large, while experiment shows that the tilting pad bearing, also, fails in the same way. It has, in fact, been shown experimentally that, if taper bearings are cautiously failed a number of times so that the bearing metal is wiped away from the trailing edge without deterioration of the surface condition and a parallel portion established along the surface, the load capacity is thereby increased.

Since my original paper on this subject, further work has shown that the parallel surface thrust bearing functions similarly at low speeds, and, in a number of cases examined, the coefficient of friction $- ZN/P$ curve is substantially the same for the speed range 1,000 to 20,000 r.p.m. In a few cases, with bearing pads of longer arc length, there is some indication that high speed gives a small reduction in friction at constant values of ZN/P well removed from the limiting values. Thus, using the argument of Shaw and Strang that the inertia theory should give a multiplicity of friction $- ZN/P$ curves, and with which I agree, these later experiments indicate that inertia has, at most, a second order effect.

During my earlier work, which covered the speed-range 10,000–20,000 r.p.m., the possibility of inertia effects accounting for the behaviour was considered and rejected because there was no multiplicity of coefficient of friction $- ZN/P$ curves. It seemed, at first, the obvious explanation, and it was only after much searching that the thermal expansion theory was put forward. Qualitatively, it seemed the only explanation which agreed with the experimental results, and the letter from Shaw and Strang does not convince me otherwise. I shall, however, look forward with great interest to seeing their promised full report on their investigations.

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Spectroscopic Arguments for Isomeric Structures in α-Chloro-Acids

In a recent paper, Renard[1] has applied a method by which the qualitative analysis of the hydrolysates of proteins seems easily realized. The first step of the process consists in transforming the α-mono-amino mono-carboxylic acids resulting from hydrolysis into α-chloro-acids; the latter having been separated into different groups by fractional distillation, Raman analysis is used to identify the compounds. The fundamental assumption made by Renard is that the spectrum of the mixture results from the superposition of the spectra of the constituent acids.

It is perhaps worth while pointing out that the Raman spectra published by Renard have certain characteristic features which indicate that this assumption is unjustifiable. Thus we observe that in each spectrum of the mono-chloro acids (propionic, valeric, isovaleric, caproic, isocaproic, β-methyl valeric) two large, diffuse bands at about 1,660 and 1,730 cm.$^{-1}$ occur, one of which is presumably due to association. By analogy with the behaviour of other acids[2] we suggest that the latter should be correlated with the $C=O$ frequency in the monomeric molecule and the former with the same frequency in the dimer. The intensities are difficult to evaluate on the enlargements, but 1,660 cm.$^{-1}$ is clearly the most intense line, which indicates considerable polymerization.

It should also be noted that a band situated at about 1,450 cm.$^{-1}$ is a double one. In some cases, we have been able to evaluate the distance between the components at about 20 cm.$^{-1}$. This could possibly be due to the splitting of the simple $C-O$ frequency in the dimer. Many other lines seem to be double, but their exact interpretation would be difficult with the data available at present.

Furthermore, when acids A and B are mixed, the existence of the following equilibria should be considered, namely:

$$\begin{aligned} 2A &\rightleftharpoons A_2 \\ 2B &\rightleftharpoons B_2 \\ A + B &\rightleftharpoons AB. \end{aligned}$$

A and B being very similar, it seems that AB must play an important part and give rise to new Raman lines the frequencies of which lie between those of A_2 and B_2. Thus, Renard's assumption on the additivity of the spectra seems premature, and for this reason alone no qualitative analysis can be undertaken before this point has been cleared up. May we remark that this is only one of the numerous points which, in our opinion, are open to criticism in Renard's paper. Among them, we might mention the precision of the measurements, which is illusory, and the contradiction between the intensity ratios of the spectral lines, which do not remain constant in the different mixtures.

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Sept. 5.

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[2] Davies, M. M., and Sutherland, G. B. B. M., *J. Chem. Phys.*, **6**, 755 (1938). Herman, R. C., and Hofstadter, R., *J. Chem. Phys.*, **7**, 460 (1939).

Fisher's "Problem of the Nile"

The following problem is of central importance in the theory of statistical estimation: k unknown parameters are to be estimated from a sample S consisting of n independent observations from the same parent population; how far can the information in S, relevant to the estimation of the k parameters, be confined to k degrees of freedom? Fisher[1] has shown that a complete solution is possible

if a set of k *sufficient* or of k *quasi-sufficient* statistics can be found, and it is known (from the work of Segal[2], further discussed by Bartlett[3]) that a simultaneous fiducial distribution will then exist, though it may not be *complete* in the sense of Bartlett. The most general parent population admitting a set of sufficient statistics has been determined by Koopman[4], but the parallel problem for quasi-sufficiency (Fisher's "Problem of the Nile") is still unsolved.

Fisher considered quasi-sufficient estimation in relation to two important examples: (1) the estimation of a location parameter; and (2) the estimation of a pair of parameters defining the location and scale of the distribution. In each example he showed that the whole of the relevant information is contained in the estimating statistics provided that these are considered in association with the *configuration* of the sample from which they have been derived. In the first example the configuration is the set of differences between the observations (arranged in descending order); in the second it is the set of ratios of these differences.

I have now generalized Fisher's results, taking the configuration of a sample of n members to consist of $n-k$ functionally independent symmetric functions of the observations, such that the configuration of a sample determines the configurations of all included sub-samples once the observations have been arranged in descending order. The integer k, the *order* of the configuration, corresponds to the number of parameters to be estimated. With this definition (and subject to certain restrictions of detail) it appears that a first-order configuration is always equivalent to the set of differences between the observations on some transformed scale, while a second-order configuration is similarly always equivalent to the set of ratios of the differences. There is a formal analogy with the theory of continuous groups which suggests that a third-order configuration is always equivalent to the set of cross-ratios of tetrads of the transformed observations, and that higher-order configurations do not exist.

Now suppose that samples from a one-parameter distribution $\varphi(x;\theta)dx$ admit a first-order configuration in the sense defined above, for which the $n-1$ defining functions have a joint distribution independent of θ. A quasi-sufficient statistic for θ will then exist, and it can be shown that the wider class of distributions described by Fisher[1] and permitting quasi-sufficient estimation of the parameter by virtue of their invariance under certain transformations are included within the present formulation. By means of a characteristic-function argument I have proved that in these circumstances the parent distribution must be of the form $\varphi(X-\lambda)dX$, where $X=X(x)$ and $\lambda=\lambda(\theta)$. (Dr. Olav Reiersøl has pointed out to me that this result bears some resemblance to one mentioned by Segal[2], the precise content of which cannot be determined as the necessary details are not given.)

In the two-parameter case the corresponding situation is less simple, and a number of additional restrictions have to be made; apart from these, however, it appears that the parent distribution must have the form

$$\varphi\left(\frac{X-\lambda}{\mu}\right)\frac{dX}{\mu}, \qquad X=X(x),$$

where (λ, μ) are functions of (θ_1, θ_2).

Thus, within the limitations of the present approach, the two examples for $k \leqslant 2$ discussed by Fisher are not only representative but exhaustive.

Apart from three-parameter distributions of the form

$$d\Phi\left(\frac{\alpha X+\beta}{\gamma X+\delta}\right), \qquad \alpha\delta \sim \gamma\beta = 1, \qquad X=X(x),$$

the parameters of which can be estimated by a set of quasi-sufficient statistics associated with the 'cross-ratio' type of third-order configuration, my results do not lead to any essentially new solutions of the notoriously difficult "Problem of the Nile", but they cover exhaustively one outstanding line of approach, and suggest that further progress in this field is most likely to be made by attempting to generalize Fisher's solution in a way which does *not* preserve one of its characteristic features—the determination of the configurations of sub-samples by the configuration of their parent.

A detailed account of this work will, it is hoped, be published during the course of the coming year.

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Aug. 2.

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[3] Bartlett, M. S., *Ann. Math. Stat.*, **10**, 129 (1939).
[4] Koopman, B. O., *Trans. Amer. Math. Soc.*, **39**, 399 (1936). Darmois, G., *C.R.*, **222**, 164 and 266 (1946), and Féraud, L., *ibid.*, 1272, should also be consulted.

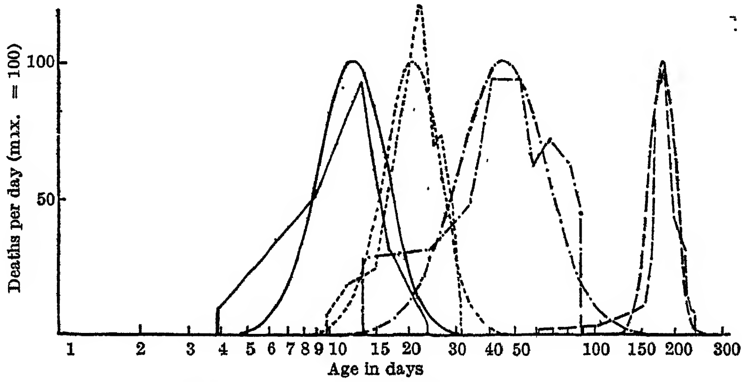
I AGREE entirely with the opinion of Dr. Kendall that future progress in this field should not be restricted to the consideration of cases in which the configuration of sub-samples is determined by the configuration appropriate to the whole sample. Such a restriction is new to me, and indeed appears artificial; it is not surprising that within its limitation the method I had illustrated should be applicable to only a few special cases. Dr. Kendall makes no mention of other illustrations I have given of the use of ancillary information.

R. A. FISHER

Representation of Relative Variability on a Semi-logarithmic Grid

THERE are two types of semi-logarithmic grids: one, called arith-log grid (a system of rectangular co-ordinates, in which the axis of abscissæ is divided arithmetically and that of ordinates logarithmically), is frequently used for graphical representations because, on such a grid, the relative increase or decrease of the intensity of a phenomenon is shown immediately by the slope of the curve obtained by plotting its value at different times; the other, which may be termed 'log-arith' grid (a system of rectangular co-ordinates in which the axis of abscissæ is divided logarithmically and that of the ordinates arithmetically), is used rarely, although this type of grid has some very useful peculiarities. It has been recognized that many moderately skew frequency distributions arising from empirical data[1] or fulfilling certain theoretical conditions[2] are reduced to normal curves of errors when plotted on a log-arith grid. Whereas the log-arith grid shares this peculiarity with other grids where the abscissa is scaled according to different functions[3], another feature, peculiar to the log-arith grid and corresponding to the well-known peculiarity of the arith-log grid, seems to have never been appreciated.

Consider two equal segments, x_1', x_1'' and x_2', x_2'', situated on the x-axis of a log-arith grid, and let their mid-points be x_1 and x_2 respectively. Then it is obvious that $\frac{x_1''-x_1'}{x_1}=\frac{x_2''-x_2'}{x_2}$. If now x_1 and x_2 represent the averages of two frequency distributions and x_1' and x_2' the respective lower (and x_1'' and x_2'' the higher) quartiles, or $x''-x'$ any other measure of dispersion, other than the inter-quartile range, the two distributions will have equal relative dispersions. In general, distribution curves which exhibit equal broadness on a log-arith grid have equal relative dispersions, higher relative dispersion is shown by a broader curve and lower by a narrower one. The log-arith grid is thus eminently suitable for the study of relative dispersion, and, in particular, in the case of distributions approaching a type which has been termed 'log-normal'[1].



DEATH CURVES PLOTTED ON A 'LOG-ARITH' GRID AS FREQUENCY POLYGONS, AND NORMAL CURVES OF ERRORS FITTED TO THEM, SHOWING THE DISTRIBUTION OF STARVED TICKS BY AGE AT DEATH AT A CONSTANT TEMPERATURE AND DIFFERENT HUMIDITIES (—— 20 %; - - - - 50 %; —·—·— 80 %; — — — 95 %)

Other methods for the graphical representation of relative dispersion have been devised[4], but their respective advantages and drawbacks will not be discussed here. Yet, the presentation of a practical example is well suited for illustrating the utility of the present method. In the figure, death curves resulting from starvation experiments on ticks (the data were communicated to me by Dr. Feldman-Muhsam, Department of Parasitology of the Hebrew University, and full details will soon be published elsewhere) have been plotted on a log-arith grid, the abscissæ being the logarithm of the age at death in days and the ordinates the number of individuals dying per day at any particular age. It can be seen from the diagram that three of the death curves present approximately the same relative dispersion, the fourth presenting a somewhat higher one. Relative dispersion, as measured by the ratio of the standard deviation to the mean, assumes corresponding values shown in column (4) of the following table.

Relative humidity (1)	Mean length of life (days) (2)	Standard deviation (3)	Coefficient of variation (4)=(3) : (2)
20%	13·7	3·7	0·27
50%	23·1	4·5	0·20
80%	48·0	22·4	0·47
95%	162·7	37·0	0·23

At the same time the table shows that both the mean length of life and the standard deviation vary so widely that it would have been impossible to plot these data on an axis of abscissæ divided arithmetically.

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July 14.

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RESEARCH ITEMS

Prehistoric Finds from Abyssinia

MR. J. DESMOND CLARK, curator of the Museum at Livingstone, has published two papers (*Trans. Roy. Soc. South Africa*, 31, Pt. 1) as a result of his visit to Abyssinia on war service. One article deals with a "Fauresmith" site about sixteen miles from Gondar on the edge of the Gondar–Debat plateau. Here the material used was a fine-grained basalt, and a number of typical hand-axes, cleavers, side-scrapers, etc., were collected, as well as several stone balls, which may have been used as 'bolas' stones. These latter are not uncommon in the earlier Stone Age industries of Africa. It is interesting to have found these "Fauresmith" implements so far north as Gondar. The second article deals with several rock-shelter sites near Yavello, a village in the Galla–Sidama province about five hundred miles south of Addis Ababa and seventy miles from the Abyssinia–Kenya border. The finds include Stillbay points, pigmy tools, scrapers of various kinds, flakes, etc. Some of the rock-shelters had been painted, the drawings being very conventionalized. Prof. H. Breuil has already noted two styles of rock-shelter painting in Abyssinia, one more naturalistic, the other very conventionalized. Mr. Clark's rock-shelter paintings would seem to belong to Breuil's latter series. Breuil also collected implements from the rock-shelters he investigated and has suggested that the industry as a whole recalls that of the Magosian culture. The industries from Yavello, judging from the drawings, could equally belong to the same culture.

Alloxan Diabetes in the Rabbit

IT was shown by Shaw Dunn and his collaborators in 1943 that injection of alloxan into animals produced a selective necrosis of the β cells of the islets of Langerhans. The animals exhibited marked hypoglycæmia during the first few hours (due to liberation of insulin from the necrotic β cells) and afterwards hyperglycæmia until death, which usually occurred within a day or two. E. Duffy (*J. Path. Bact.*, 57, 199; 1946) has succeeded in tiding rabbits over the initial acute and (hitherto fatal) stage by appropriate treatment with glucose or insulin. Such animals survived for many months and exhibited classical symptoms of diabetes mellitus—hyperglycæmia, glycosuria, polyuria, polyphagia. Ketonuria was not present on ordinary diets, though, surprisingly, it could be induced by feeding excess of glucose but not by high fat diets. Post-mortem, the only findings were degeneration and reduction in number of the β cells. It is therefore proved that the classical picture of diabetes can be produced by selective damage to the β cells of the pancreatic islets.

Accelerated Storage Tests to Assess the Quality of Dried Whole-Egg Powder

EGGS in powdered form have become a well-known commodity during the war years, and the extent to which this commodity will compete with other egg products during normal times will depend largely on how well its quality can be maintained not only during production but also in handling and storage. Fluorescence appears to be related to protein decomposition in foods, which show more decomposition as spoilage proceeds; and it has been found that the addition of sucrose to egg powder, prior to drying, is effective in delaying fluorescent development at 118° F. R. L. Hay and J. A. Pearce (*Canad. J. Res.*, F, 24, 168; 1946) now show that 33 per cent sucrose in the egg powders has a marked effect in retarding decrease in quality in egg powder as assessed by all quality tests used. Loss in quality is less for sugar-egg powders prepared with granulated sugar than for those prepared with sucrose syrup; and in addition, powder made from fresh shell eggs is more desirable than powder prepared from frozen melange. Present indications are that this sugar-egg powder will find a ready peace-time market for baking and other trade purposes.

Seed Germination and Light

J. A. HONING (*Genetica*, 23, 1; 1944) has shown that the seeds of *Nicotiana Tabaccum* from Sumatra in general require light for germination, but those from Java are light-indifferent. Pure lines are light-indifferent or light-needing. Hybrids between these lines show reciprocal differences when stored in the presence of lime, but the differences largely disappear when storage is done without lime. *N. texana* also contains strains which have light-sensitive seeds.

Stem Rot of Outdoor Tomatoes

TOMATO stem and fruit rot (*Didymella Lycopersici* Kleb.) is a frequent cause of loss in outdoor tomato crops and may persist from year to year with varying severity on regularly cropped holdings. C. J. Hickman (*J. Pom. and Hort. Sci.*, 22, 69; 1946) has investigated sources of infection in the Evesham area, following the observation that the disease occurred on widely separated holdings supplied with plants from a particular nursery where it had been identified. By mixing seeds from diseased fruits with healthy seeds, samples containing 2 per cent and 70 per cent infected seeds were obtained. Plants raised from these seeds were grown on separate plots, and though no signs of disease were apparent at planting time, a quarter of those from the 2 per cent sample and a third of those from the 70 per cent sample eventually succumbed. Plants from healthy seed became diseased when propagated at nurseries having a previous history of infection, whereas no losses occurred where there was no such history and hygiene was good. Plants in the field were not prone to infection from the soil, even when diseased plants had been ploughed in the previous year. Plants staked with old canes, however, became 38 per cent infected, whereas new canes, or old canes sterilized with formaldehyde, produced no infection. It is concluded that the most probable causes of the disease are spores in propagating soil and spores which have overwintered in cracks of old canes.

Mitotic Activity in the Mouse

W. S. BULLOUGH (*Phil. Trans. Roy. Soc.*, B, 231, 435; 1946) has made an extensive analysis of mitosis in the adult mouse. The reproductive system, the urinary system, the alimentary canal, various exocrine and endocrine glands and other organs of the female mouse all exhibit increased mitotic activity in response to œstrogenic hormones. In the ovary the cells are highly resistant to the mitosis-stimulating effect of the œstrogen. The evidence shows the presence of mitosis inhibitors which may be classified as (1) the cell inertia, (2) mitosis depressors. The latter show their effect by taking control immediately after an excess of mitotic activity has been stimulated by œstrogen. Therefore in the presence of a stimulant and the depressant, mitosis proceeds in waves. The proliferating cells of the intestinal lymph appear to

lack the depressant, and continued excessive mitosis may occur. Both in the neighbourhood of wounds and in cancerous growth there is a maximum response to œstrone; the two regulators would appear to be in abeyance. These results are discussed in relation to ovarian function, pregnancy and cancer.

Magnetic Field Calculation by Relaxation Method

In a paper by H. Motz and W. D. Worthy (*J. Inst. Elec. Eng.*, 92, Pt. 2, No. 30, December 1945), a method of computing magnetic and electric fields is explained with reference to the problem of the magnetic flux distribution between stator and rotor of dynamo-electric machines. Mathematically, the problem is that of solving Laplace's or Poisson's equation. It is shown how approximate solutions are obtained with the help of a simple arithmetical technique. The differential equations are first replaced by a system of algebraic equations which are then solved by means of the computation method due to R. V. Southwell. The process is outlined and illustrated by a simple example which shows all the essential steps involved. A solution is given for two idealized examples of pole shoe and armature for which rigorous solutions are known. The agreement between the rigorous and approximate solutions is found satisfactory. Sharp corners of pole shoe and armature present a problem for which various solutions are possible, and some of these are indicated. The flux distribution of a complete machine is computed and presented as an example of a complex problem not amenable to a rigorous solution.

High-Frequency Alternators

A paper by Dr. J. H. Walker (*J. Inst. Elec. Eng.*, 93, Pt. 2, No. 31, February 1946) reviews the various types of alternators available for the generation of frequencies up to 50,000 c./s., and shows that for the majority of applications the modern heteropolar inductor alternator is the most suitable machine. It demonstrates that this alternator is superior to the older homopolar and heteropolar types, owing, in the case of machines required for frequencies of 400–3,600 c./s., to a system of field and armature windings which substantially reduces the number of armature conductors required to generate a given electromotive force. For frequencies greater than 3,600 c./s. this superiority is due to a combination of these windings with a stator-slotting arrangement which permits, for a given frequency and speed of rotation, a large reduction in the number of wound stator slots. The electrical characteristics and mechanical construction of these alternators are discussed, together with their application to the melting of metals and surface-hardening of steel. An appendix gives a brief mathematical treatment of the theory of their novel features.

Physical Properties of Aliphatic Hydrocarbons

Considerable interest has recently been shown in the determination of the physical properties of pure hydrocarbons, and the results of A. I. Vogel (*J. Chem. Soc.*, 133; 1946) on the parachors and refractivities of the normal hydrocarbons from *n*-pentane to *n*-hexadecane add some valuable material to this field. The results differ markedly from hitherto accepted figures, and since the atomic and structural parachors and refractivities depend on the values of the CH_2 grouping, the calculations based on these will require modification. The mean values for CH_2 are: $[P] = 39{\cdot}98$, $R_C = 4{\cdot}618$, $R_D = 4{\cdot}643$, $R_F = 4{\cdot}687$, $R_G = 4{\cdot}731$ and $Mn_D^{20} = 20{\cdot}63$. Taking into account the values found for *n*-alkyl chlorides, bromides and iodides, the average values $[P] = 40{\cdot}02$, $R_C = 4{\cdot}624$, $R_D = 4{\cdot}647$, $R_F = 4{\cdot}695$, $R_G = 4{\cdot}735$, and $Mn_D^{20} = 20{\cdot}59$ are found. It is suggested that the data of Eisenlohr for the refractivities are less accurate than has been supposed.

Structure of Vanadium Tetrachloride

The structure of the vanadium tetrachloride (VCl_4) molecule has been determined by electron diffraction by W. N. Lipscomb and A. G. Whittaker (*J. Amer. Chem. Soc.*, 67, 2019; 1945). The molecule is a regular tetrahedron, with V—Cl = $2{\cdot}03 \pm 0{\cdot}02$ A. and Cl—Cl = $3{\cdot}32 \pm 0{\cdot}03$ A. The V—Cl distance is in good agreement with that calculated on the assumption that six orbitals are involved in bond formation to the four chlorine atoms and each bond has ½ double bond character. The unpaired electron probably occupies one of the 3*d* orbitals not involved in bond formation, and it is interesting that this electron does not take any significant steric role (similar to that ordinarily played by an unshared electron *pair*) in the structure, the observed tetrahedral configuration being that which would be expected if this electron were absent.

Structure of the Globular Star Clusters

E. Finlay-Freundlich (*Mon. Not. Roy. Ast. Soc.*, 105, 4, 237; 1945) has attempted to explain the existence of isolated globular star clusters in the vicinity of the galaxy. The main problem presented by the globular star clusters is their existence as finite systems, isolated from the field of the galactic stars. Their structure must be determined solely by the gravitational field set up by the stars which constitute such a cluster. But whether the influence of the gravitational field of the whole cluster alone, or in addition, the influence of irregular forces, arising from critical approaches of individual stars, is considered as a decisive factor, it has been shown by Charlier and Martens that the final state should correspond in every case to an isothermal distribution. It has been recently discovered that globular clusters have wide envelopes of faint stars and, taking into consideration these 'atmospheres', the clusters have well-defined finite radii. From these facts the theory is developed that the globular clusters are settling down from an initially adiabatic state, and have reached an intermediate, quasi-stationary state consisting of an isothermal core surrounded by an adiabatic atmosphere. On this view an explanation is afforded of the fact that the most strongly elliptical cores have the lowest atmospheres, and in addition, the fact that the ellipticity, frequently shown in the bright stars, is restricted to the cores, is explained. From the width of the spectral lines in the spectrum of the bright cores, it is possible to determine approximately the masses of globular star clusters, and preliminary estimates show that these masses are very large—of the order 10^8 that of the sun. Although such masses exceed those previously assumed for the masses of the globular clusters, corroborative evidence for the large mass is afforded by the high spatial velocities of the few cluster-type variables discovered outside globular clusters in the galaxy; and these velocities, it is assumed, can be interpreted as velocities of escape. Such velocities correspond to a mass of about 4×10^8 times the mass of the sun.

THE BIOLOGICAL INSTITUTE OF TIHANY, HUNGARY

THE Hungarian Biological Research Institute is situated near the village of Tihany on a small peninsula running out from the northern shore of Lake Balaton. It is about a hundred miles south-west of Budapest in an attractive position on the edge of the lake with wooded hills behind.

The Institute, founded in 1926, was well known before the War as the largest freshwater biological station in Europe; and the plant and animal life of the lake and its shores have been the subject of intensive study. The lake itself is fifty miles long, 6–9 miles wide and 10 ft. deep on the average; near Tihany the depth increases to about 30 ft.

During the War the Institute was fortunate in having suffered comparatively little material damage and has now become the main centre for biological research of all kinds in Hungary. With Dr. A. B. L. Beznak as director, accommodation has been afforded to workers who would otherwise have been deprived of facilities for research by the destruction of their laboratories in other parts of Hungary; in this manner an isolated residential community has been created of some seventy scientific workers, many of whom had earned international reputations before the War. The isolation is partly physical due to the present lack of transport, and partly scientific due to difficulties in maintaining contact with men of science in other countries; in recent months institutions and individuals in Great Britain have been sending a certain amount of scientific literature which has been very gladly received and has helped to keep research going at the Institute.

The work of the hydrobiological department is directed by Dr. Bela Entz, assisted by Dr. Olga Sebestyen. Research is concerned mainly with limnological problems; in particular, investigations on organic detritus, on biocœnesis, on *Cladocera*, on phytoplankton and on sponges are being carried out or are projected.

Dr. J. Horvath is now working on soil fertility, sterility and exhaustion, and later intends to work on soil bacteriology.

Research in plant physiology is being carried out by L. J. Havas, mainly in relation to colchicine; he proposes to investigate effects of vegetable substances on animal tumours and pathogens.

Dr. L. Felföldi is concerned with plant geography and plant sociology; he is also interested in cyto-genetics and hopes to study polyploid plants with a view to their practical applications.

Drosophila research is being done by Dr. G. Fabian, who has found and bred his own special stock. Present work is concerned with inheritance of fertility and sterility; it is later intended to work on the biochemistry of gene substances.

Work on the sociology of birds is carried out by Dr. N. Udvary, who studied bird life on the Hortobagy during the War.

Dr. S. G. Maltoltsy is investigating cell physiology and has recently been working on the hereditary effects of carcinogenic materials on *Drosophila* and on plants, and on the biological effects of ultra-violet rays.

Research on animal physiology is being done by the director, Dr. A. B. J. Beznak, by his wife, Dr. M. Beznak, and by Dr. I. Hajdu; the work is mainly concerned with the physiological mechanism of the hyperglycæmia caused by the thrombosis or ligat[ure] of one of the heart vessels. The physiolog[ical] mechanisms of heart hypertrophies and of supra[renal] hypertrophies as well as the physiology of nutrit[ion] have also been studied by these workers.

Dr. T. Csaky plans to study the biochemistr[y of] nutrition and also the production of protein f[ood] stuffs for human and animal nutrition by the ac[tion] of synthesizing agents such as yeast and nitro[gen-]fixing bacteria.

Dr. A. G. B. Kovacs is concerned mainly with animal metabolism. He is now working on the physiological mechanism of the temperature response following histamine injections. In the future he wants to work on the part played by histamine in the central nervous system, and on surgical shock.

Dr. Zsuzsanna Rady works mainly on human nutrition, and after completing the results of a survey of nutritional conditions at the comparatively wealthy village of Valko, intends to carry out a similar research at the poorer village of Tihany. She hopes in this way to relate the needs of the population in a particular locality to the agricultural conditions of the country, and hence to make recommendations for the manner in which agriculture should be developed. At present she is working on the protein metabolism of fish, on fungal diseases in fish and on the bacteri-cidal action of their skin secretions.

Biochemistry is represented by Dr. M. Gerenda[s] who is working at present principally on bloo[d] clotting and the isolation and inactivation of thromb[in] and also (in collaboration with Prof. Szent-Györgyi) on muscle structure.

In addition to the researches mentioned above work on organic (sterol) chemistry is being done b[y] Dr. A. Kramli and on experimental animal psycholog[y] by Dr. M. Nagy.

THERMODYNAMIC EQUILIBRIA O[F] HIGHER ORDER

FOR two phases of the same substance to be [in] equilibrium, the thermodynamic potential, G must have the same value in both phases. P. [S.] Epstein ("Textbook of Thermodynamics", p. 13[1;] 1937) has suggested that, in order to derive th[e] equilibrium conditions, the Taylor series for G shoul[d] be expanded to terms of high order. If, in thi[s] expansion, the nth order derivatives of G are th[e] lowest which have different values in the two phase[s] and all derivatives of lower order are equal in th[e] two phases, then $d^nG' = d^nG''$ is the condition fo[r] equilibrium of the nth order, where the symbols (') and (") indicate the separate phases. E. F. L[ee] (*Phys. Rev.*, 69, 652; June 1946) has follow[ed] Epstein's suggestion and derived from the abo[ve] condition the set of thermodynamic relations, whi[ch] in addition to the equivalence of the potentials, m[ust] hold for a system of a single substance which is [in] nth order equilibrium.

The relations for the equilibria of the first [...] orders, and the equations of the correspond[ing] equilibrium curves, are examined in some detail. [In] a system in first-order equilibrium, the equatio[n of] the equilibrium curve is simply the Claus[ius–] Clapeyron equation. The transitions, between [the] two modifications of liquid helium, and betw[een] those of solid methane, have been interpret[ed as] second-order equilibria. Adequate descriptions o[f]

...ition curves, and of the thermodynamic properties of these substances along the curves, have ... given (for helium by Keesom, and for methane ...lusius and co-workers), so that the theoretical ...ons obtained by Lype can be checked by comparison with experiment. It is shown that the ...ons yield values for the physical properties ...n are in excellent agreement with those observed, ...ev... when Ehrenfest's equation (*Leiden Comm. Supp.*, 75b, 1933), which has been applied to second-order equilibria, leads to values twice as high as the observed values.

Certain transformations in metals, such as the transition at the Curie point from the ferromagnetic to the paramagnetic state, or between two forms of a crystal lattice, as observed, for example, for cobalt at 450° C., have been considered to represent equilibria of the third order. The equation for the third-order transition curve is used to calculate the variation of the transition temperature with pressure, and in the case of nickel at the Curie point, for which reliable experimental data exist, good agreement is obtained between the value calculated by Lype and the experimental value determined by Englert (*Z. Phys.*, 97, 94; 1935).

Although the existence of a fourth-order equilibrium has not yet been observed, this order of equilibrium is of interest, as a means of extending the vapour pressure curve beyond the critical point. It is shown that the points of inflexion of various thermodynamical functions in the overcritical region can be regarded as such an extension, and some verification for this, though sufficient data are lacking, is obtained by comparison with the experimental values of the specific heat of high pressure steam in the overcritical region as measured by Havlíček and Miškovský (*Helv. phys. Acta*, 9, 161; 1936).

NATIVE CULTURE OF THE MARIANAS ISLANDS

THE Marianas Islands in Micronesia have not received so much attention from anthropologists as have most of the other island groups, and yet they present an extremely interesting field of study ("Native Culture of the Marianas Islands." By Laura Thompson, *Bernice P. Bishop Museum Bull.*, 185; 1945). Discovered by Magellan in 1521, these islands were a regular stopping place for the early voyagers, but the inhabitants were left practically undisturbed for about 150 years. In the middle of the seventeenth century, a permanent mission was established by a band of Jesuits supported by Spanish soldiers. The natives, who numbered about 100,000, were friendly but resisted conversion; however, with the help of the soldiers their resistance was overcome ... the reduced population gave in to Spanish domination. The population was further diminished by other factors (disease, etc.), and in the first census ... in the eighteenth century, only some 3,678 natives survived. These intermarried with the Spaniards, Filipinos and others, and a mixed population completely replaced the indigenous one, the cultures blending with influences both from the Old and the New Worlds to form a new pattern. To-day ... the Chamorro language, altered by Spanish ...ions, persists.

There are, however, archæological remains and a number of old Spanish documents from which much can be deduced concerning the Chamorro, who are remarkable for their size and strength and for their fondness for the water. From these documents, Laura Thompson has pieced together a reasonably detailed account of the daily life and social structure of the vanished tribe, together with their material culture, and much of interest emerges. It is clear that the ancient Chamorro had an elaborate social organisation with matrilineal clans and village chiefs whose power was based mainly on inherited wealth and monopolies. The society was divided into three classes, the upper and middle consisting of sailors, carpenters, fishermen and warriors, which professions were not open to the lower and physically inferior class. Their economy was of the usual South Sea type, based on gardens, food collecting and fishing, but different in that rice was also cultivated.

Taking it all round, the ancient Chamorro had a highly developed neolithic culture which rivalled in interest the high centres of central and marginal Polynesia, and may be compared to the Indonesian or pre-Malay level in the Philippines.

K. RISHBETH

FORTHCOMING EVENTS

Wednesday, October 2

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Scientific Papers.

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. H. J. T. Ellingham: "Chemical Metallurgy".

Thursday, October 3

PHYSICAL SOCIETY, COLOUR GROUP (at the Lighting Service Bureau, E.L.M.A., 2 Savoy Hill, London, W.C.2), at 3 p.m.—Mr. N. E. G. Hill: "The Recognition of Coloured Light Signals which are near the Limit of Visibility" and "The Measurement of the Chromatic and Achromatic Thresholds of Coloured Point Sources against a White Background".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. V. Z. de Ferranti: Inaugural Address as President.

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. Max Jakob: "Some Experiments on Forced Convection".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, October 4

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (in the Lecture Theatre, Central Library, St. Peter's Square, Manchester), at 6.30 p.m.—Prof. E. K. Rideal, M.B.E., F.R.S.: "Physical Chemistry in the Dyestuffs Industry" (Ivan Levinstein Memorial Lecture).

Saturday, October 5

ASSOCIATION FOR THE STUDY OF SYSTEMATICS IN RELATION TO GENERAL BIOLOGY (at the Royal Botanic Gardens, Kew), at 2.15 p.m.—Exhibits and demonstrations on Modern Plant Systematics.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT CHEMISTS in the Chief Inspector's Department—The Clerk and Solicitor, West Riding of Yorkshire Rivers Board, 71 Northgate, Wakefield, Yorks, endorsed "Assistant Chemist" (October 1).

LECTURER IN ELECTRICAL ENGINEERING—Acting Clerk to the Governors, South West Essex Technical College and School of Art, Forest Road, London, E.17 (October 3).

HORTICULTURAL INSTRUCTOR at the Pibwrlwyd Farm Institute, Carmarthen—The Director of Education, County Education Offices, County Hall, The Castle, Carmarthen (October 5).

UNIVERSITY READERSHIP IN EXPERIMENTAL PHYSIOLOGY at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 7).

LECTURER IN CIVIL ENGINEERING—The Principal, Technical College, Normanton Road, Derby (October 7).

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Aberdeen (October 11).

LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT—The Principal, Aston Technical College, Whitehead Road, Birmingham 6 (October 14).

RESEARCH WORKER IN THE COAL TREATMENT LABORATORY of the Department of Chemical Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (October 15).

TEMPORARY LECTURER IN CIVIL ENGINEERING (appointment for three years) at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 15).

HEAD OF THE DEPARTMENT OF CHEMISTRY—The Principal, Chelsea Polytechnic, London, S.W.3 (October 17).

RESEARCH ASSISTANT FOR CANCER RESEARCH in the Department of Pathology—The Registrar, The University, Sheffield (October 19).

ASSISTANT PHYSICIST—The Secretary, Sheffield National Centre for Radiotherapy, "Broom Cross", Tree Root Walk, Sheffield 10 (October 21).

SENIOR LECTURER IN CHARGE OF THE DEPARTMENT OF POLITICAL SCIENCE at the University of Melbourne, Vic., Australia—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 28).

ENGINEER FOR AUSTRALIAN ALUMINIUM PRODUCTION COMMISSION, in Australia—The Deputy High Commissioner for Australia, Room 115, Australia House, London, W.C.2 (October 31).

DIRECTOR OF RESEARCH in a new Mechanical Engineering Research Organisation to be established by the D.S.I.R.—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1631 (November 8).

DIRECTOR OF RESEARCH in a new Hydraulics Research Organisation to be established by the D.S.I.R.—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1632 (November 8).

ZOOLOGIST and a BOTANIST—The Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland (November 15).

SCIENTIFIC OFFICER at the Tea Research Institute of Ceylon, St. Coombs, Talawakelle, Ceylon—Secretary, Ceylon Association in London, King William Street House, Arthur Street, London, E.C.4 (November 30).

ZOOLOGIST in "Scientific Officer" class—The Director, Freshwater Biological Association, Ambleside, Westmorland (November 30).

LECTURER IN INDUSTRIAL HEALTH—The Registrar, The University, Manchester 13 (December 1).

ADVISORY OFFICERS (3) for Association's Scientific Department, Assam—The Secretary, Indian Tea Association (London), 39 Lombard Street, London, E.C.3.

ASSISTANT BACTERIOLOGISTS for Research Department at Port Sunlight, Cheshire—Lever Brothers and Unilever, Ltd., TD/R, Unilever House, Blackfriars, London, E.C.4.

ASSISTANT CHEMIST for research in fruit and vegetable preservation—The Director, Research Station, Campden, Glos.

ASSISTANT IN THE DEPARTMENT OF NATURAL HISTORY (preference will be given to applicants specially qualified in Invertebrate or Agricultural Zoology)—H. J. Butchart, Secretary, The University, Aberdeen.

ASSISTANT LECTURER IN [B]OTANY AND ZOOLOGY—The Principal, Chelsea Polytechnic, London, S.W.3.

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

CHIEF PLANT PHYSIOLOGIST for Research Division, Department of Agriculture and Forests, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1.

HEAD OF THE DEPARTMENT OF BIOLOGICAL SCIENCES—The Secretary-Registrar, Wye College, near Ashford, Kent.

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

VACANCIES ON THE SCIENTIFIC STAFF, for research and development work on flax bleaching, spinning and weaving—The Director of Research, Linen Industry Research Association, The Research Institute, Lambeg, Co. Antrim, Northern Ireland.

LECTURER IN ZOOLOGY—The Registrar, Municipal College, Portsmouth.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Nuffield College. The Further Education of Men and Women: a Task of the 1944 Education Act. Pp. 72. (London: Oxford University Press, 1946.) 1*s*. net. [65

Wilberforce House, Hull: its History and Collections. Pp. 20. (Hull: Mortimer Museum, 1946.) 4*d*. [85

South-West Essex Technical College and School of Art. Annual Report, Session 1944–45. Pp. 32. (London: South-West Essex Technical College and School of Art, Walthamstow, 1946.) [85

Ministry of Health: Department of Health for Scotland. Report of the Inter-Departmental Committee on Remuneration of General Practitioners. (Cmd. 6810.) Pp. 31. (London: H.M. Stationery Office, 1946.) 6*d*. net. [135

Current Affairs, No. 1: Food and Famine. By F. Le Gros Clark. Pp. 20. Current Affairs, No. 2: Treaty Making. By Harold Nicolson. Pp. 16. (London: Bureau of Current Affairs, 1946.) Fortnightly, 8*s*. 6*d*. per annum. [135

Map Review. No. 1: From April 8th to April 17th, 1946. 40 in. × 30 in. No. 2: From April 18th to May 1st, 1946. 40 in. × 30 in. (London: Bureau of Current Affairs, 1946.) Fortnightly, 18*s*. 6*d*. per annum. [135

Soil-less Cultivation of Carnations. Pp. 38. (London: British Carnation Society, 1946.) 2*s*. 6*d*. [135

Weather. Vol. 1, No. 1, May. Pp. 32 + 4 plates. (London: Royal Meteorological Society, 1946.) Monthly, 1*s*. 6*d*.; 18*s*. per annum. [135

Other Countries

Meddelelser om Grønland udgivne af Kommissionen for Vi kabelige Undersøgelser i Grønland. Bd. 131, Nr. 14: The D mination of the Harmonic Constants from Tidal Observations ma Danmarks Havn. By J. Egedal. Pp. 6. 0.50 kr. Bd. 132, N Die Triasablagerungen von Ostgrönland. (Geologisk Ekspeditio Østgrønland, 1936–38.) Von Hans Stauber. Pp. 326+7 plates. Bd. 133, Nr. 1: Die Postdevonische Tektonik von Ostgrönland chen 74° und 75° N. Br. Von Andreas Vischer. Pp. 194+6 p 12 kr. Bd. 134, Nr. 1: Kommissionens Historie, 1878–1943. A Bistrup. Pp. 92. 4 kr. Bd. 134, Nr. 2: The East Greenla Possibilities of Existence, their Production and Consumption, Ejnar Mikkelsen, in conjunction with P. P. Sveistrup. Pp. 24 plate. 11.50 kr. Bd. 134, Nr. 3: Den økonomiske Udvikling i C tianshaab, Jakobshavn og Ritenbenk Distrikten, 1899–1938. A Friis-Nielsen og P. P. Sveistrup. Pp. 162+1 plate. 8 kr. (Kø havn: C. A. Reitzels Forlag, 1942–1944.)

La bimanità: sintesi sommale dei principi fondamentali del pen bimano. Pp. 32. (Milano: Casa Editrice Pollini, n.d.) 5 lire.

Bernice P. Bishop Museum. Special Publication 37: Studie Hawaiian Pollen Statistics, Part 1: The Spores of the Haw Pteridophytes. By Olof H. Selling. Pp. 87+7 plates. (Honol Bernice P. Bishop Museum, 1946.)

Publications of the South African Institute for Medical Rese No. 47: Statistical Results of Ten Years of Typhoid Endoto Immunization on the Witwatersrand Gold Mines (1934–1943). Dr. E. Grasset. Pp. 163–206. (Johannesburg: South African I tute for Medical Research, 1945.)

Ella Sachs Plotz Foundation for the Advancement of Scie Investigation. Twenty-second Annual Report, 1945. Pp. 4. (Bos Mass.: Dr. J. C. Aub, Secretary, Massachusetts General Hos 1946.)

Meddelelser om Grønland udgivne af Kommissionen for Vid kabelige Undersøgelser i Grønland. Bd. 135, Nr. 3: A Geolo Reconnaissance of the Southern Part of the Svartenhuk Penin West Greenland. (De Danske Nügssuaq Ekspeditioner, 1938 og 19 By Alfred Rosenkrantz, Arne Noe-Nygaard, Helge Gry, Sole Mu and Dan Laursen. Pp. 72+5 plates. 4 kr. Bd. 135, Nr. 8: Contr tions to the Quaternary Geology of Northern West Greenland espec the Raised Marine Deposits. (De Danske Nügssuaq Ekspeditio 1938 og 1939.) By Dan Laursen. Pp. 126+7 plates. 8 kr. Bd. Nr. 3: On the Geology and Petrography of the West Greenland Ba Province, Part 3: The Plateau Basalts of Svartenhuk Penins (De Danske Nügssuaq Ekspeditioner, 1938 og 1939.) By Arne Nygaard. Pp. 78+10 plates. 4.50 kr. Bd. 137, Nr. 5: On the Geo and Petrography of the West Greenland Basalt Province, Par Two Major Doleritic Intrusions of the Nugssuaq Peninsula. Danske Nügssuaq Ekspeditioner, 1938 og 1939.) By Sole Mu Pp. 62+15 plates. 4.50 kr. Bd. 138: Studies on Triassic Fis 1. (Palaeozoologica Groenlandica.) By Eigil Nielsen. Pp. 394 plates. 22 kr. Bd. 141, Nr. 3: Studies on the Oribatids and Coll boles of Greenland. By Marie Hammer. Pp. 210. 10 kr. Bd. Nr. 1: Contributions to the Geography of Ingolfs Fjord and Interior of Kronprins Christians Land. By Elmar Drastrup. Pp. 1 kr. (København: C. A. Reitzels Forlag, 1942–1945.)

Oversigt over Meddelelser om Grønland afsluttet i Marts 1 Udarbejdet af H. Bistrup. Pp. 84. 4 kr. Supplement afsluttet 31 December 1943 til Oversigt over Meddelelser om Grønland afslu 1 Marts 1941. Udarbejdet af H. Bistrup. Pp. 32. 1.50 kr. (Kø havn: C. A. Reitzels Forlag, 1941–1945.)

Havsforskningsinstitutets Skrift. No. 113: Översikt av is under vintern 1936–37. Av Risto Jurva. Pp. 71. No. 115: Över av isarna under vintern 1925–26. Av Risto Jurva. Pp. 55. No. Översikt av isarna under vintern 1921–22. Av Risto Jurva. Pp. No. 117: Översikt av isarna under vintern 1923–24. Av Risto Ju Pp. 44. No. 121: Strom- und Windbeobachtungen an den Fe schiffen in den Jahren 1936 und 1937. Von E. Palmén. Pp. 57. 123: Zur Frage des prognostischen Wertes der Wassertemperatu Schärenmeer. Von Eugenie Lisitzin. Pp. 21. No. 124: The Thala logical Cruise April–May 1938. By Risto Jurva. Pp. 16. No. Havsforskningsinstitutets verksamhet under år 1938. Av Gu Granquist. Pp. 17. No. 126: Regular Observations of Tempera and Salinity in the Seas around Finland, July 1937–June 1938. Gunnar Granquist. Pp. 43. No. 127: The Thalassological Cruis July 1939. By Gunnar Granquist. Pp. 25. No. 128: Hydrograph Observations made on board the S.S. *Aranda* during the Internati Investigation of the Central Baltic, July–August 1939, 1: Tempera Salinity and Oxygen. By Gunnar Granquist. Pp. 24. (Helsi Havsforskningsinstitutet, 1939–1944.)

Havsforskningsinstitutets Skrift. No. 129: Regular Obse tions of Temperature and Salinity in the Seas around Finl July 1938–June 1939. By Gunnar Granquist. Pp. 40. No. Vattenståndsvärden 1937 och 1938. Av E. Palmén. Pp. 92. 131: Hydrographische Beobachtungen an bord vom Finnis Forschungsdampfer *Aranda* während der Internationalen Ost Expedition im Juli und August 1939, 2: Strombeobachtungen. Ilmo Hela und Erkki Laurila. Pp. 14. No. 132: Über die was standsschwankungen in Liinahamari (Petsamo). Von Eugenie L zin. Pp. 20. No. 133: Wasserstandsregistrierungen in Ha 1904–1920. Von E. Palmén. Pp. 41. No. 134: Über die Schwa ungen des wasserstandes in der Ostsee mit besonderer Berücksich ung des wasseraustausches durch die dänischen Gewässer. Ilmo Hela. Pp. 108. No. 135: Regular Observations of Tempera and Salinity in the Seas around Finland, July 1939–June 1940. Gunnar Granquist. Pp. 37. No. 136: Vattenståndsvärden 1 och 1940. Av E. Palmén. Pp. 80. (Helsinki: Havsforskni institutet, 1940–1945.)

Northern Rhodesia: Department of Agriculture. Annual Re for the Year 1944. Pp. 12. (Lusaka: Government Print, 19 1*s*.

Zoologisk Museum i København gennem tre aarhundreder. Ragnar Spärck. Pp. 110. (København: Ejnar Mun 1945.)

Dyr i Natur og Museum: Aarbog for Universitetets Zoologi Museum 1944–45. Pp. 142. (København: Ejnar Munksga 1945.)